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Central Eurasia: Space

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SPACE SCIENCES

SPACE ENGINEERING

SPACE APPLICATIONS

SPACE POLICY, ADMINISTRATION

Model of the Gas-Dust Cloud in the Flame of a High-Altitude Rocket

937Q0013 Tomsk OPTIKA ATMOSFERY I OKEANA in Russian Vol 6 No 4, Apr 93 pp 458-468

[Article by L. S. Ivlev, V. I. Romanova, St. Petersburg State University; UDC 551.509]

[Abstract] The chemical composition of the exhaust jet leaving the nozzle of a rocket motor varies, of course, with the type of fuel burned. In studying the space-time characteristics and structure of the irregular cloud created by the rocket flame, the researchers construct a model of the gas-dust cloud in the rocket's wake. The model portrays cloud configuration, pressure-density distribution, and gas-dynamic parameters. Four succeeding areas of the cloud are delineated along the trajectory of the powered leg of the rocket's flight: the area near the nozzle (dispersal into the vacuum), the strong-shockwave area (equivalent to automodel stage of a point explosion), the weak shockwave area (nonautomodel stage of point explosion), and the sound-wave area (described by linear acoustics equations). Figures 5, references 6 (Russian).

Moon as Natural Standard for Calibrating Spectrophotometric Subsatellite Observations

937Q0004A Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 27 No 4, Jul-Aug 93 pp 47-64

[Article by S. G. Pugacheva, V. V. Novikov and V. V. Shevchenko, State Astronomical Institute imeni P. K. Shternberg; UDC 523.3]

[Abstract] The principles for use of the moon and bright planets (Jupiter, Saturn) as a natural standard for calibrating false color space photographs of the Earth's surface are validated. The principal points in a method for calibrating scanner images of the Earth's surface in the visible (0.45 μm) and far-IR (10-12 μm) wavelength ranges using the moon are outlined and the requirements on the initial material are defined. It is proposed that a database of spectrophotometric measurements of the brightness of individual sectors of the lunar surface and digital models of light scattering by the lunar surface be used in calibrating the photographs. An image of the lunar surface in visible and IR light is automatically reproduced on the display screen of a PC for calibrating and normalizing the results of spectrophotometric measurements of terrestrial natural features. The present-day moon is close to a state of thermal equilibrium. The radiation of heat through the surface corresponds to its generation in the deep layers. The principal source of lunar surface heat is solar radiation; neither micrometeorites nor streams of ultrafast particles can serve as additional sources of lunar heating. The ancient moon, cold and passive, not having an atmosphere, is accordingly a stable natural standard making it possible to calibrate and normalize the results of spectrophotometric measurements of other natural objects from space in both the visible and IR ranges. Figures 4; references 25: 18 Russian, 7 Western.

Management of Catalogue of Artificial Space Objects

947Q0002A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31 No 4, Jul-Aug 93 pp 101-114

[Article by Z. N. Khutorovskiy, UDC 523.89]

[Abstract] A catalogue of space objects of artificial origin (SOAO) is being used in evaluating the safety of space flights, constructing space-time models of the flux of SOAO, determining the time and region of cessation of existence of dangerous SOAO, tracking of inoperable vehicles and orbital stations, lifting of false alarms caused by observations of SOAO in systems for warning of a missile attack and antimissile defense. A block diagram shows the structure and functioning of the system employed. Important identification criteria are discussed. A catalogue listing more than 5000 SOAO with a diameter of more than 10 cm, whose orbital parameters are continuously being determined with greater accuracy from measurements by radar detection stations, is being maintained in an automatic mode by the service for the monitoring of space over the territory of the former USSR. An outline of the procedures for the processing of measurement data is given. Some characteristics of the existing system are presented, in particular, the number of objects being observed in different stages of the tracking process, trajectory parameters and characteristics of detection of fragments of decayed SOAO, accuracy in determining and predicting the orbits of SOAO and accuracy in determining the time and region of cessation of existence of SOAO. The results of work for determining the lifetime and region of falling of the Salyut-7 - Cosmos 1686 orbital complex are given as an illustrative example. The characteristics of speed, reliability and accuracy of the algorithms and programs used in identifying measurements with objects in the catalogue, refinement of orbital parameters, detection of new objects and prediction of motion are described. Figures 3.

Results of Observations of X-Ray Source 4U1700-37 With WATCH Instrument of 'Granat' Observatory

947Q0003A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 19 No 8, Aug 93 pp 675-685

[Article by S. Yu. Sazonov, I. Yu. Lapshov, R. A. Syunyayev, S. Brandt, N. Lund and A. Castro-Tirado, Space Research Institute, Russian Academy of Sciences, Moscow; Space Research Institute, Lyngby, Denmark; UDC 520.6;524.354]

[Abstract] The results of observations of the X-ray source 4U1700- 37 with the WATCH instrument of the

"Granat" observatory during the period from September 1991 through October 1992 are presented. The WATCH instrument consisted of four X-ray detectors, outfitted with rotating collimators, of which three are now in operation. These detectors operate in the energy range 8-60 keV, divided into two subranges: 8-20 and 20-60 keV. A period of seven years had elapsed since observations of the object by the EXOSAT, making it possible to check the hypothesis of acceleration of the rotation of this binary. The new observations revealed that the flux from the source experiences strong variability with characteristic times from hours to months. It was found that there is a decrease in the orbital period of the binary system at the rate $P/P = -(4.13+/-0.19) \times 10^{-6}$ year^{-1}. Brightness curves illustrating the strong variability of the X-ray flux from the source at different time scales are presented. The constructed orbital phase curves of 4U1700-37 are virtually symmetric relative to the phase j0.5 in the energy range 8-60 keV. Figures 6; references 15: 4 Russian, 11 Western.

Observations of Cosmic Gamma Burst of 23 July 1992 by WATCH Instrument of 'Granat' Observatory

947Q0003B Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 19 No 8, Aug 93 pp 686-692

[Article by O. V. Terekhov, V. A. Lobachev, D. V. Denisenko, I. Yu. Lapshov, R. A. Syunyayev, N. Lund, A. Castro-Tirado and C. Brandt, Space Research Institute, Russian Academy of Sciences, Moscow; Space Research Institute, Lyngby, Denmark; UDC 520.6;524.7]

[Abstract] A cosmic radio burst, registered by the "Granat" observatory on 23 July 1992 at $20^h03^m 08^s.377$ (UT), was one of the brightest events which was observed during the time of its operation beginning in December 1989. This burst was registered by three burst instruments on the observatory (PHEBUS, SIGMA and WATCH). Data are given on the Russian-Danish WATCH experiment for localization of the burst source and determining the brightness curve in different energy ranges and evolution of the hardness of the detected radiation. It was found that the gamma burst source radiates attenuating X-radiation with a characteristic temperature of about 5 keV in the approximation of an ideally black body spectrum over the course of more than 40 s after the end of the burst in hard X-rays. The limitations on the luminosity of the stationary source present at the site of the burst in the X-ray range (8-20 keV) are given. It is shown that the flux from the stationary source present at the site of the burst did not exceed 20 mCrab over a period of at least several days before and after the event. Figures 6; references 13: 2 Russian, 11 Western.

Prospects for Russian Radiotelescope Sites' Cooperation With U.S. VLBI Network

947Q0012A Moscow SEGODNYA in Russian 7 Oct 93 p 8

[Article by Mikhail Chernyshov: "Americans Have Become Owners of Largest Radiotelescope. If Russian Efforts Are Joined to Theirs Mankind Will See 'Another' Universe"]

[Text] As reported in the American press, construction has been completed in the United States on the world's largest radiotelescope having a span of 8000 km. The "antenna" consists of ten 25-m dishes arranged in a circle which takes in almost the entire territory of the United States, including islands in the Pacific and Atlantic Oceans. The telescope is called the Very Long Baseline Array (VLBA). Using computers housed at the National Radioastronomical Observatory (New Mexico), specialists manipulate operation of all the individual units as a single instrument. Its keenness of vision (resolution) is a thousand times greater than for the best optical telescopes. And since the VLBA operates in the radio wave spectrum, a picture of a seemingly completely new universe opens up before the observer. For example, with the still not fully constructed instrument astronomers registered a remarkable surge of matter from the nucleus of one of the active Markaryan galaxies, named in honor of an Armenian astronomer. The surge was twisted at an angle of approximately 90 degrees. In the opinion of specialists this indicates that in nature there are ultrastrong magnetic fields until now not known to science. Instruments similar to the VLBA also serve for strictly terrestrial work. For example, through these same quasars superdistant from us they are capable of determining the distance between the Earth's continents with an accuracy to centimeters. In precisely such a way it was established that tectonic plates, serving as the basement for the jcontinents, slowly drift relative to one another. Measurements made using the VLBA gave evidence that: North America is drifting away from Europe at a rate of 2 cm each year. Such an accuracy in determining tectonic displacements, it is assumed, will make possible more reliable earthquake prediction. The birth of radioastronomy dates to the 1930's, but it began to flourish after the war when a great many "idle" large sounders were left over. It was clarified that they not only can track hostile aircraft, but also can listen to the voices of the universe. Today many instruments seemingly may have dual use: strictly scientific and at the same time can be used, shall we say, for obtaining information necessary in systems for the guidance of ballistic missiles. But, to be sure, such unique instruments as the VLBA operate primarily in the sphere of fundamental science. As the NEW YORK TIMES reports, two scientists, the Russian Leonid Matveyenko and the British astronomer Phillip Dimond, working with the VLBA, discovered evidence of the existence of a protoplanetary system forming around one of the stars in the constellation Orion. It can be assumed that this sensational event will soon be confirmed by new data because it is proposed that the observational capabilities

of the VLBA be augmented by connecting other radiotelescopes, both American and foreign, including Russian instruments, to it. During recent years the work of world astronomers has experienced great changes. Once each country preferred that its observatories operate independently. Specialists exchanged research results only by means of publications in scientific journals and at symposia. A sort of private competition went on between different countries: where would the most powerful instrument be constructed? This was evidence of the productive and intellectual capabilities of the country. In the 1960's-1970's the USSR made an active pretense to a leading position in the field of telescope construction. This also applied to radioastronomy. A ring of metallic dishes, the RATAN-600, having record parameters, was erected at Zelenchukskaya station (Northern Caucasus) in the neighborhood of a 6-m optical giant. The world's largest decameter- range radiotelescope was constructed in the Ukraine, not far from Kharkov. In Uzbekistan preparations were made for construction of the RT-70. And this is not to mention instruments at lesser scales. Also with respect to "cup" antennas the attainments were impressive. It jis sufficient to recall the enormous structures appearing at Yevpatoriya, Ussuriysk and Ozero Medvezh'ye. Each of them in essence constituted a gigantic robot capable of conducting a dialogue with the sky in an automatic mode. Moreover, such dish antennas, to be sure, of somewhat lesser dimensions, appeared on so-called "scientific ships" sailing the expanses of the world ocean. Not every person could get on these ships, even with a "first-class pass." Today the "prestige race" has ended, but comparable capabilities are nevertheless necessary for cooperation. Lev Gindelis, a specialist at the State Astronomical Institute imeni Shternberg (GAISh), very familiar with the subject, feels that Russian radioastronomy is going through a difficult period. Although scientists are trying to keep up their contacts, there are a great many difficulties on their path: financing of programs, operation of available equipment, not to mention new construction. Take that same radiotelescope in Uzbekistan, the RT-70. Enormous sums were spent on it, the instrument was almost ready, but there was no possibility of completing the work. Numerous discussions are going on concerning the establishment of an international radioastronomical center on the basis of the RT-70, but no pertinent statements of intentions have been issued. In general, however, Russian radiotelescopes have already exhausted their capabilities. No revolutionary discoveries are to be expected, although many routine investigations remain which also are very important in science. The predictions of Nikolay Kardashev, corresponding member, Russian Academy of Sciences, director of the Astronomical Center, Physics Institute, Russian Academy of Sciences, are more optimistic. He is convinced that many radio observatories will begin to receive sums along the lines of the Russian Space Agency. In addition, between the Russian Space Agency and the Ukrainian Space Agency there is an arrangement on the joint financing of some programs. With respect to cooperation with specialists from distant foreign countries, here there is even more certainty than in interrelationships with colleagues from the Commonwealth countries. The Astronomical Center of the Physics Institute has arranged, in particular, constant contact with the American National Radioastronomical Observatory and is conducting a regular exchange of specialists. The joining of Russian radiotelescopes with the American VLBA is possible. The greater the base (the distance between two antennas) of an instrument of this type, the greater is the resolution of the observation instrument. If the operation of the "dishes," for example, in the Hawaiian and Virgin Islands, at Ussuriysk and in the Moscow jregion, are synchronized, we obtain a base comparable to the dimensions of the planet. But this is not all. The idea was already conceived long ago—experiments in this direction have been made—to launch one or more radiotelescopes into high orbits. Satellites of the Astronom type have been constructed for this purpose in Russia. The "earth-space" base for such a superinstrument exceeds a hundred thousand kilometers. Work under these programs has been dragged out. But if everything is put into order and goes without hitches in 1996 we will become witnesses of the launch of a radioastronomical satellite.

Golitsyno-2 Spaceflight Control Center

947Q0019A Moscow KRASNAYA ZVEZDA in Russian 9 Oct 93 p 2

[Article by Valeriy Baberdin: "It Is Close From Golitsyno-2 to Orbit"; the first paragraph is an introduction]

[Text] The Earth space service consists of communication, navigation, meteorological prediction and mapping satellites. There are about 180 units of just our Russian vehicles operating in space today. They are controlled by specialists of the Military Space Forces. More than 200 officers daily stand watch at command-measurement complexes scattered over the entire country. Precisely they are the principal links in the space system.

A stereotyped perception gained currency long ago: the Spaceflight Control Center is that hall whose image is usually transmitted by television during the course of reports on space events. But this is only window dressing. All the everyday rough work is done at Golitsyno-2, a once supersecret facility, in documents assigned the number 413. Or expressed differently, the Main Center for Testing and Control of Space Vehicles.

The day when we were there preparations were being made for launching the Raduga-41, the next communication satellite. Panels of information on the course of preparatory operations at the cosmodrome lit up on the display screen in the main control hall.

... At 2006 a Proton booster will be launched from Baykonur which will put a satellite into reference orbit, then a propulsion unit will be fired and the vehicle will be delivered to the designated point. This is a point in geostationary orbit at a distance of about 36 000 km from the Earth.

"If everything goes normally," says Major General Anatoliy Zapadinskiy, chief of the main center, "late at night we will begin to work directly with the vehicle—analyze the telemetry, measure the orbit and check to see whether all the principal components have deployed and whether the systems are functioning. But at the same time we keep all other satellites in the field of view. In the evening, for example, we will work with the Mir and communicate with the cosmonauts Vasiliy Tsibliyev and Aleksandr Serebrov. We make up to a thousand communication contacts with objects each day."

Here the main responsible figure is the chief organizer, the commander of the crews on duty. He commands all the crews on duty in the Military Space Forces—ranging from Kamchatka, Transbaykalia and Vorkuta to Shchelkovo in the Moscow region and Krasnoye Selo near St. Peterburg. Earlier there were important points near Feodosiya, in Yevpatoriya and in Uzbekistan, but after the breakup of the USSR they were lost to us.

Has this exerted an influence on military readiness? To be sure. For an entire year it has been necessary to load other points to the limit. Some of the work has been shifted to the east and Shchelkovo has been outfitted with new apparatus.

"Now," continues Zapadinskiy, "things have settled down. Although it is a pity that equipment which is not needed by anyone there is being wasted."

Naturally, the shortage of funds is exerting an effect. The changeover to new surface equipment has dragged out endlessly. And after all it is necessary to launch a series of new vehicles: GLONASS, Globus, Gals, Ekspress. Without them the country simply cannot live for a day. These represent communication, these represent television for the Far East and North, these represent radio broadcasting.

"Do you know," asks the general, "how our system was created? Through the decades, brick by brick, structure by structure. And now it can collapse instantaneously. And the prerequisites for this exist. Are political ambitions involved here?"

History, Present Significance of Kapustin Yar Cosmodrome Discussed

937Q0032 Moscow KOMSOMOLSKAYA PRAVDA in Russian 26 Nov 93 p 3

[Article by Igor Yemelyanov: "This Yar Wasn't So Easy To Come By: Our First Space Launch Facility Hears the Roar of Rockets Less and Less Often"]

[Text] When the United States got its hands on the German V-2s in '45, it was soaring high in the sky. The USSR managed to get only the crumbs from the German rocket pie, but we had S. Korolev and V. Glushko and the pride of the victors.

On October 18 of '47, the first Soviet rocket, the R-1, flew its first 207 km. It launched from the top-secret testing grounds of Kapustin Yar. Out of 10 proposed sites strewn across the Union, a piece of the Volga steppe the size of a small European state was chosen. They say that Lawrence Berry [Lavrentiy Beriya] himself kept tabs on the project.

They didn't allot much time to hammer out the country's missile shield, throwing three engineering-construction brigades from the front to Kapustin Yar. V. Voznyuk, the katyusha specialist who had rocketed from major to general in one year of the war, created a super testing ground on the barren spot at Stalin's command. The railroad to it from Stalingrad didn't go through a single population center.

The military watch began with the R-2, the absolute favorite of the testers for the 6 tons of alcohol that went in to make up the fuel. The R-5 was the first missile with a nuclear warhead to rush to the east. They say there that, to this day, no one knows whether it exploded or not, or where it could have happened. The famous R-12s, which were hauled to Cuba in order to settle the Caribbean crisis, stood "cocked" for a full 30 years and were regarded as the strongest of the fingers of our nuclear fist. True, the alcohol in them was long gone, but the parity with the Yankees wasn't shaken. The RSD-10 (SS-20), which was born in '73 and shocked all our enemies, had no match for many years. When the United States got wind of them, it decided right then and there to make peace with the "evil empire."

The road was carved out for Gagarin by 48 dogs launched from Kapustin Yar. The first to go aloft, in the summer of '51, were not Belka and Strelka, who were also prepared here, but Dozik and Tsygan. Later one pioneer died, and a second lived with S. Korolev's family. A dog by the name of Otvazhnaya [Brave] went up four times. But not all of them were drawn to the stars—one animal decided to run away just before the launch, right from the launch pad, and they had to send the nearest mongrel up into space in its place. But it didn't matter, they got the job done for the party and the government.

At Kapustin Yar, they built the first artificial Earth satellite, which was put into orbit from Baykonur. At Kapustin Yar, they worked the bugs out of the space television, radio, and telephone communications.

The heaviest fog of secrecy had barely lifted in '73, when we helped the Poles lift their first, the Copernicus-500, to the proper altitude. We launched the friendly Indian Ariabata series in '75, and after that, even the French were allowed to go to orbit from there.

Buran, which engendered a flurry of enthusiasm when it took off and landed in Kazakhstan, was painstakingly built in the Volga region under the supervision of German Titov.

But in the '80s, we got "caught up," as it were, in big space. The USSR had another space jacket—Baykonur

Hit over the Urals on the first of May in '60, the American pilot Powers had been quite [illegible] as he bailed out of the cozy U-2. His superiors had not warned him that the Russians had the Volkhov S-75 antiaircraft missile complex, which laughed at the high-altitude jet capabilities of the reconnaissance plane from the States. They didn't warn him because they didn't know the Russian had it.

The antiaircraft testing grounds had broken away from its strategic missile brother in '51, and within less than two months, it roared with the first vertical-launch surface-to-air missile. The multichannel creation was outfitted to protect the motherland's capital. Within three years, the surface-to-air missile complex was firing at 20 targets at once. In May of '55, first Moscow, and then other important centers and borders were bristling with the arrows of SAMs.

The first mobile SAM unit, the Dvina, was combat ready in late '57, near Brest. A version of it, the Volkhov, not only interrupted the spy flight over the center of the Soviet military-industrial complex, but also let the United States know that the USSR was ahead of everyone else on the planet in air defense, which meant that it was hazardous to flit about perniciously over one-sixth of the land surface.

The Volkhov, and later the Pechora, made their way to 40 countries and didn't do badly in the confrontation with Phantoms in Viet Nam and Mirages in the Near East.

In just two years at Kapustin Yar, they "rolled out" the first automatic system for controlling SAMs. The mid-60s saw the appearance of radar systems for detecting enemy aircraft. Finally, unique simulator systems were created in the '70s. That is, by turning on a computer, but without launching aircraft or rockets, they were able to work out the bugs there in combat with any air attack that might happen. The Americans were gnashing their teeth with envy. And in February of '93, all they could do was hold on to a pillar in Abu Dabi: in the Arabian sky, Russian-made S-300s on the fly knocked out two cruise missiles. The sheiks gave a standing ovation.

Do you remember the story about the "submarine in the Ukrainian steppes?" It's not altogether a myth. In Kapustin Yar, in an immense basin, is a sub in which they used to test sea-launched missiles. Generally speaking, Kapustin Yar is replete with legends. The burst of myth-making began between '88 and '91, when 654 intermediate-range SS-20 missiles were being destroyed here.

Legend No. 1: nuclear explosions occur in the Volga steppes. In fact, the warheads have been removed in other places, and here they've only exploded batches of airframes.

Legend No. 2: as a result of the explosions in Kapustin Yar, windows have shattered, walls have cracked, and, in Volgograd, homes have been demolished. On August 30 of '90, Academician Ye. Velikhov reported in an analysis that the seismic vibrations 5 kilometers from the explosion site do not exceed 3 on the scale. It's 28 kilometers to Kapustin Yar, the windows in the local department store shattered only once, when a fighter plane broke the sound barrier over the city.

Legend No. 3: a massive die-off of sheep was associated with the missiles. A commission of the main directorate, veterinarians, and a scientific research institute found sulfur and arsenic in the wool and livers of the sheep that died. The lab head from the All-Union Scientific Research Institute, G. Kashfutdinov, suggested that "the main reason for the deaths was, apparently, the rocket-fuel combustion products of unknown composition." We could brand the fleecing missile-people, but the "rocket fuel products" of the SS-20 contain neither sulfur, nor arsenic; the emissions of the Astrakhan Gas-Condensate Combine, however, does contain those products.

The keys to the Kapustin Yar, a city of 32,000 closed off by three checkpoints, are held in two hands—that of the garrison leadership and that of the city government. And although the small Astrakhan Oblast Council pointed out on May 17 of this year that, according to current law, the civilian executive body is supposed to reign in Kapustin Yar, the real boss of that settlement is Gen. V. Tonkikh.

But that doesn't mean that the missile arm of authority and the civilian arm of authority are locked in battle under the carpet. Last April, the local police, together with the military, averted a massive action of youth that was meant to "run out of town" Kavkaz people who had been attracted to Kapustin Yar to revive trade. It was averted without any injuries. Over all of '93, there was only one murder.

The initial impression that it's mainly sports figures and top models who live there was confirmed in a visit I made to the sports complex, which has a pool, a shooting range, and a stadium.

Today, the leasing of launch pads in Kazakhstan, which may be seeing their last winter, costs billions, and their equipment and people can and should be transferred to a re-outfitted Kapustin Yar, where products and fuel don't have to be brought in by plane.

And if Plesetsk, planted in the northern bogs, can be regarded as the Russian equivalent to the Kapustin Yar missile testing grounds, then the air-defense testing grounds in Zavolzhye is the only one in Russia. We no other sites where we can do a professional job of testing antiaircraft systems that tomorrow would protect both the country and its interests in local conflicts. Where else is it possible to be demonstrating to hard-currency buyers, on a permanent basis, new SAM complexes in all their glory (China has already bought a batch of S-300s, Kuwait is thing about it, although what's there to think about—the Patriots are more expensive and not as good)? In the opinion of V. Korolev, the deputy chief for science of the air-defense testing grounds, any and all kinds of weapons from any of the combat arms could be tested in Kapustin Yar.

Whatever the military doctrine, it would be stupid to not preserve the Kapustin Yar testing grounds after having made them into a base for the country's armed forces and having abandoned expensive foreign launch pads.

Modern Gas Dynamical Models in Super- and Hypersonic Aerodynamics and Heat Exchange Problems

937Q0194A Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian No 4, Apr 93 pp 15-29

[Article by G. A. Tirskiy, Moscow Physical Technical Institute; UDC 533]

[Abstract] This is a critical review of the Russian and foreign literature on ways to compute the principal characteristics of streamline flow around bodies during their entry into the atmosphere under so-called continuous medium conditions. Methods for solving the full Navier-Stokes equations and different simplified equations are examined: boundary layer, thin (hypersonic) shock layer, full viscous shock layer equations and different modifications of parabolized Navier-Stokes equations (the literature contains not less than ten Navier-Stokes equations models, but only these, the most important, are examined). A separate section is devoted to the details of each of these cases, with an appraisal of their effectiveness under given conditions. Such an examination is important because Navier-Stokes equations have not yet assumed their due role due to their unwieldiness and heavy requirements on computer time when all the essential nonequilibrium physicochemical processes are taken into account. The mathematical properties of the corresponding equations, features of the numerical solution and dependence of the field of applicability of these models on the principal determining parameters of the problem and their hierarchy are discussed. It is shown that the use of Navier-Stokes equations models makes it possible to find a solution of many two-dimensional problems of practical importance with a high degree of accuracy within the framework of a single algorithm using a computer of moderate capacity. Figure 1; references 77: 53 Russian, 24 Western.

Numerical Study of Two-Phase Flows in Plug Nozzles

937Q0194B Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian No 4, Apr 93 pp 81-91

[Article by I. M. Vasenin, A. A. Glazunov, V. A. Ivanov, N. A. Obukhov, A. V. Shamin and V. S. Shishkin, Applied Mathematics and Mechanics Scientific Research Institute, Tomsk State University, and Machine Building Design Bureau imeni Academician V. P. Makeyev; UDC 532.529]

[Abstract] The results of numerical investigations of the gas dynamics of two-phase (including swirling) flows in plug nozzles, such as used in aerospace technology for creating a jet thrust, are given. The published literature contains no information on such plug nozzles. It is shown that particles in great quantity are precipitated on the walls of nozzles shaped for the flow of an ideal gas. This is true in the case of rocket engines operating on solid metallized fuels whose combustion products contain great numbers of precipitating particles. A method for reducing the precipitation of particles on the plug contour by means of swirling of the flow is examined. Two-phase monodisperse flow in nozzles of the plate and post types are examined in detail. The ranges of subsonic and supersonic velocities are considered separately. A wide range of variables is taken into account, such as intensity of swirling, dispersity of condensate particles and weight fraction of condensate. Complicating factors are analyzed and special cases are considered. Effective methods for shaping plug nozzles for two-phase flows are proposed, with consideration given to efficiency, economy, stability, reliability and simplicity in application. Figures 12; references: 15 Russian.

Problem of Optimal Control of Terminal Spacecraft Orientation

937Q0001A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31 No 4, Jul-Aug 93 pp 12-17

[Article by M. V. Levskiy; UDC 629.7]

[Abstract] Terminal reorientation of a spacecraft is defined here as a change in the orientation of a spacecraft in an inertial system of coordinates over a given time period from its initial angular position to a required end position. Although a number of researchers have studied optimal control of terminal reorientation, few have focused on precise determination of globally optimal controls that provide minimum fuel expenditure. In fact, that problem has been solved for only a plane turn about the principal axis of inertia and a spatial turn of a spherically symmetrical body. Prompted by the fact that there has yet to appear a method that would analytically solve in general form the problem of spatial reorientation of a nonsymmetrical spacecraft with a minimum fuel consumption constraint, the researcher here presents a numerical algorithm with a predictive model in which the spacecraft is an absolute solid, the possibility of nonalignment of axes of ellipsoid of inertia and body axes is disregarded, the controlling moment is shorter than turn time, and the angular momentum transferred to the body exceeds considerably the angular momentum acquired during the turn from the external disturbances. The spacecraft is assumed to be dynamically symmetrical relative to the longitudinal axis, and the disturbing moments are negligible. The model predicts free motion in the rotation class from conical trajectories. Control of terminal reorientation in the model consists of the following steps: computation of the quaternion of the turn, determination of initial conditions for the free segment, and determination of calculated angular momentum and controlling moments for coordinates x, y, and z; acceleration of the spacecraft to the required angular momentum; free motion of the spacecraft until half of the angle of turn is achieved; at

moment t_1, determination of new quaternion; determination of initial conditions for new segment; determination of required impulse δK, and computation of controlling moment; suppression of spacecraft angular velocities. Figures 1, references 6 (Russian).

Rotation of Prognoz-9 Satellite

937Q0001B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31, No 4, Jul-Aug 93 pp 18-28

[Article by E. A. Vitrichenko, B. Ya. Dolgopolov; UDC 623.7]

[Abstract] The Relict-2 experiment, which is to continue studies of the background radiation of the Universe, requires a star tracker capable of determining the triaxial orientation of a rotating Prognoz-type spacecraft. Oreol-3, which is to perform that task, must effect onboard solution of the problems associated with that determination. Accordingly, all the features of the angular motion of the Prognoz-type satellite must be studied. Although there is little specific data on the nature of the rotation of Prognoz satellites, a voluminous amount of data does exist for Prognoz-9. The researchers focused on that particular satellite and found that it always has a positive angular acceleration, although a negative third derivative of angle in terms of time sometimes appears. Angular velocity is disrupted at times, with angular acceleration undergoing simultaneous disruption. The researchers also found that the axis of rotation of the satellite oscillates periodically. Differences in the laws of rotation can factored into algorithms in two ways: by tracking a "watch" star on each revolution and plotting a polynomial for it, or by observing the variation in angular velocity. Oscillations in the axis of rotation that last several hours do not lead to a loss of orientation if the second approach is used and if the time interval selected is considerably smaller than the period of oscillation. Figures 3, references 17 (Russian).

Model of Star Tracker for Relict-2 Project

937Q0001C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31, No 4, Jul-Aug 93 pp 29-37

[Article by V. V. Vilmont, E. A. Vitrichenko; UDC 623.7]

[Abstract] The Prognoz satellite in the Relict-2 experiment will be in the vicinity of the second Sun-Earth Lagrange point. The ultimate task of the Oreol-3 star tracker will be to provide all the instruments aboard the spacecraft a reference point for the beginning of the orbital revolution, i.e., some signal issued when the optical axis of the tracker intersects with a given major circle on the celestial sphere. In developing the Oreol-2 instrument, the researchers used a combination of two approaches: physical study, e.g., on a test stand, and computer modeling. The computer simulation of the instrument models one- and three-slit trackers, various spin poles, and rotation of the Prognoz-9 satellite. The star tracker ultimately developed and built has the following characteristics. The precision of determination of orientation parameters is 4 arc sec. The optical unit draws 0.18 W, weighs 0.54 kg, and has dimensions of 100 x 80 x 220 mm. The computer unit pulls 1.4 W, weighs 3.0 kg, and is 200 x 200 x 90 mm in size. The instrument's lens has a diameter of 10 mm; focal length is 20 mm. Lens distortion is -8.6 (K_1), 0.96 (K_2), and 0.10 (K_3). Photometric field error is 26; scattering spot diameter, 16 μm; dark pulse counting rate, 500/s; quantum efficiency of photomultiplier, 0.1; effective spectral band width, 1700 angstroms; number of slits, 3; angle of inclination of lateral slit, 18°. The linear dimensions of the slits are 10 mm (l_1), 0.02 mm (d), 4 mm (l_2), and 2.95 mm (a). The γ and φ errors are 0.0 in both cases. Figures 3, references 17: 15 Russian, 2 Western.

Charging Effects of Dielectrics in Onboard Communication Links of Spacecraft

937Q0001D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 31, No 4, Jul-Aug 93 pp 123-126

[Article by R. M. Zaydel; UDC 550.388:537.221]

[Abstract] A satellite that spends a lengthy time in orbit is exposed to the charged particles (mainly electrons and protons) of the Earth's radiation belts, the electromagnetic radiation of the Sun, and cosmic gamma quanta. That exposure results in overall and differential charging. Charge accumulation in the thin outer layer of the dielectric leads to a local electric field, and when the field strength exceeds the electric strength of the material, there is a discharge that is accompanied by the emission of electromagnetic interference in a broad band of frequencies. That disrupts the operation of onboard radio gear. This paper examines the possibility of charging of the dielectrics in the cables that connect onboard radio units and assemblies, primarily communication lines that run either along the outer surface of the satellite or under a thin aluminum cover. Unlike earlier work examining this problem, the researchers conclude that when there is a breakdown of the cable dielectric, charge collection takes place not along the entire line, but from a segment with a length on the order of the cable diameter. The voltage wave associated with a discharge, behind whose front the field reaches a kilovolt per centimeter, may minimize the series of subsequent discharges on other segments of the communication line. Figures 1, references 8: 7 Russian, 1 Western.

NPO Molniya Continuing Work on MAKS Aerospace System

947Q0011A Moscow SEGODNYA in Russian 7 Oct 93 p 8

[Article by Veronika Romanenkova: "Russian Aircraft Builders Enthused by Triplanes. And Dream of Buran Progeny"]

[Text] The First Moscow Aerospace Show had scarcely ended and Russia was already preparing for another large-scale event: the First International "Aviation-Development Paths" Conference. This forum, which will be held in Moscow during the period 23-26 November, is oriented on assistance in the exchange of experience and new ideas, a broadening of scientific-production and commercial relationships among organizations and companies engaged in developing and using aviation technology.

As reported in a conversation with a SEGODNYA correspondent, the chairman of the conference presidium, Gleb Lozino-Lozinskiy, general director and chief designer of the NPO Molniya, says that the main themes of the forum should be the general line of development, efficiency, safety and economy. He feels that these requirements are satisfied to the greatest degree by a so-called triplane which in addition to ordinary wings and a tail also has a forward supporting surface. Such a design makes it possible to increase flightcraft efficiency by 8-10%.

The NPO Molniya has already for a quite long time been engaged in the development of such triplanes in different variants. For example, the first copies of the standard-produced six-seat Molniya-1 triplane should appear this month. The 15-19-seat Molniya-100, whose flight range is 500-1000 km and whose speed is about 300 km/hour, is in the development tage. The Molniya-300 also is now being created. It is a ten-seat triplane capable of making flights of 4000-5000 km with a speed 850 km/hour. The NPO also has plans for building aircraft with a great load capacity, in particular, the Gerakla, capable of transporting 450 tons of cargo.

The Molniya specialists also are not forgetting their main "child," the Buran. Gleb Lozino-Lozinskiy reported that despite the severe financial situation it is not planned that this project will be put on the shelf during the coming year. Scientists and designers are now working on a successor of the Buran: the multipurpose aerospace system MAKS. It is assumed that the broad conquest of space will be possible only when the cost of putting one kilogram of payload into orbit is reduced by a factor of 8-10—today this is about 10 000 dollars. Use of the MAKS system promises such a possibility.

The attractiveness of such a project is yet to be backed up by financial resources. At the NPO Molniya, not counting on state subsidies, a search is on for foreign partners, with whom, naturally, it will be necessary to share the right of MAKS ownership. This, to be sure, is better than bringing the work to a complete end, but hope still remains for national sponsors.

Study of the Relationship Between Weather Changes and Cosmic Factors

937Q0006A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 93 pp 3-11

[Article by M. V. Bukharov, Hydrometeorological Scientific Research Center of the Russian Federation, Moscow; UDC 629.78:551.5]

[Abstract] Because cosmic factors have relatively little influence on weather changes, most researchers rarely focus on them. However, cosmic factors must be taken into consideration for purposes of long-term weather forecasting. This paper examines one approach to explaining the overall mechanism underlying the relationship between weather variations and specific parameters. The unifying hypothesis is that weather changes can be regarded as random events whose probability grows with the values of disturbing parameters such as level of solar activity or parameters driven by variations in the gravity fields of celestial bodies. In turn, solar activity, for example, can also depend on parameters that characterize variations in planetary gravity fields. Data obtained showed that despite the large number of factors on which weather depends, variations in the strength of the Moon's gravitational pull on the Earth can have a substantial effect on short-term weather variations. Accordingly, since one cause of precipitation is cyclic, the dynamics of precipitation may be a function of changes in lunar gravity field. It is also noted that extremes in lunar variations are observed several times over the course of one lunar revolution around the Earth, a phenomenon that could produce something of a synchronism between the angular velocity of the orbital motion of the Moon and the rate of movement of cyclones from west to east. The researchers also note that new methods of long-term weather forecasting could be based on cosmic factors. Figures 3, references 13 (Russian).

Digital Production of Radar Images of the Earth's Surface in the Synthetic-Aperture Radar of the Almaz-1 Spacecraft

937Q0006B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 93 pp 33-43

[Article by L. B. Neronskiy, V. G. Kobernichenko, S. M. Zrayenko, Moscow Scientific Research Institute of Instrument-Making; Uralskiy Polytechnical Institute, Yekaterinburg; UDC 551.501.81:621.396.963.3]

[Abstract] The principles and features of the digital processing of the signals of the SAR Ekor-A during radar imaging are examined. The Ekor-A, which went aloft aboard the Almaz-1 spacecraft in 1991, was the first such radar in which the entire imaging process was digital. In the Ekor-A, the survey mode is preceded by the measurement of the central Doppler frequency and the turning of the spacecraft's longitudinal axis in relation to a line of the path to the angle corresponding to the central Doppler frequency of 750 Hz, with subsequent stabilization of the spacecraft in that position during the survey. Since a signal without intrapulse modulation is used as the probe signal, range compression is absent. The algorithm for the digital processing is based on piecewise-linear approximation of the reference function and requires assignment of input data in the form of readings of quadrature components of the trajectory signal. General requirements for the digital imaging synthesis circuit are as follows: number of range readings in in 1/6 survey swath, 972; maximum number of processed azimuth readings, 2000; maximum amount of data to memory in imaging, 2×10^6 5-bit words; number of azimuth reference functions in processed swath, 3-4. The PS-2000 multiprocessor is the primary ground-based unit for processing the SAR signal. The improvements in speed that are achieved in the SAR itself stems from simplified processing in each subaperture. The system can produce 62,500 image readings per second, which enables a frame of 40 x 40 km to be processed in about 12 minutes. Figures 4, references 7: 6 Russian, 1 Western.

Use of Satellite Scanner Images for Identifying Large Burned-Out Forest Areas and Areas Damaged by Forest Fires

937Q0006C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 93 pp 83-93

[Article by V. V. Furyayev, Forest and Timber Institute imeni V. N. Sukachev, Siberian Department, Russian Academy of Sciences, Krasnoyarsk; UDC 528.88.042.4: 634.434]

[Abstract] Ground and aerial techniques of tracking forest fires and assessing the damage done by them have serious drawbacks in that they are labor-intensive, often highly inaccurate, and subjective. In addition, sparsely populated areas of the taiga, forest-tundra, and tundra are often unpatrolled. Satellite scanner images represent a more adequate and accurate means of tracking forest fires and mapping the damage. Images of burn areas in 1979 in the Nizhnyaya Tunguska River basin and the northwest Baykal region are presented in this paper. The researchers here recommend use of a combination of aerial and satellite survey—specifically, Resurs-O surveys. Resurs-O is the only satellite system whose coverage includes the entire country. Images are radioed down daily. The All-Union Scientific Research Institute of Forest Resources has developed a system of automated identification and registration of areas damaged by forest fires; initial information for the system consists of scanner images in the 0.5-0.7 μm and 0.8-1.1 μm ranges. Figures 2, references 23 (Russian).

Decrease in Total Ozone Over St. Petersburg From Nimbus 7 TOMS Data

937Q0015 Moscow DOKLADY AKADEMII NAUK in Russian Vol 331 No 5, Aug 93 pp 622-624

[Article by K. Ya. Kondratyev, K. Varotsos, International Center for the Environment and Remote Sensing imeni F. Nansena, St. Petersburg; Athens University; UDC 528.88.04.041.1:551.501]

[Abstract] The fundamental difference between the atmospheric circulation conditions over the Arctic and those over Antarctica preclude the possibility of the formation of large, stable holes in the ozone layer over the Arctic. Observational data, however, indicate that mini-holes may form. That prompted the researchers here to study the data of observations made by the satellite-borne TOMS instrument over St. Petersburg during the period 1978-1992. Average monthly total ozone peaked in March and April, tapering off gradually to a low in November, with a relatively steep climb back up to peak values beginning in December. When the researchers compared theoretical values with observational values, they found the latter to exceed the former considerably. Numerical modeling of ozone layer dynamics, for example, suggested that the decrease in total ozone at 60°N lat should be about 2 percent; observations, however, placed that value at 8 percent. They conclude that measurement of month-to-month trends in total ozone is critical. Figures 4, references 12: 5 Russian, 7 Western.

NPO Energiya Developing Fuel Cells, Other Civil Technologies

937Q0016 Moscow ROSSIYSKIYE VESTI in Russian 22 Oct 93 p 4

[Article by Vadim Chernobrov, under the rubric "Courier of the S&T Revolution: Spacecraft for Going Underwater"]

[Text] "Our main focus, as before, is space," begins Yuriy Petrovich Semenovich, general designer of NPO Energiya, referring to the NPO. "But that doesn't mean that we are never involved in things that are purely 'ground-based.' We just don't use 'ground-based' approaches when we solve the simplest of problems. If we tackle the production of a consumer product, then it's going to be of a quality that is no less astonishing than is that of our spacecraft."

Even before, the famous association—which for many years was headed by Korolev, Mishin, and Glushko—used to receive a quota assigned from higher echelons for the production of products of the national economy. In no way did that offend the pride of the gray-haired space "majordomos." They looked at it this way: it was all just the whimsy of the top-secret people, as they strove to convince the reconnaissance people of the West that the huge rocket-building shops were actually producing crockpots and bicycles.

Together with the word "conversion," the people at the association have learned what an "complimentary order" is. Top government officials have explained to the rocket-builders that "nobody but them would be able to set up mass production of modern prostheses so well." And just like that, we set it up. With just one "but"—initially, not just the quality, but also the cost approached what could be called "cosmic."

Together with the word "market," they also learned what "profitable order" is. The market has not only forced them to seek out means of lowering the cost of prostheses, but also hinted to them other spheres in which they can use their experience. These days, more often than not it is not top government officials who are coming to Energiya, but ordinary customers with their own business proposals. For example, ideas have been implemented for the creation of power-engineering installations that run on casing-head natural gas. The joint-stock company Gazprom has long had the idea of using that gas, which, to this day, is burned in huge quantities in extraction regions. And yet, helicopters are used to bring-in "gold" solar oil for the energy needs of the settlements that reside near the flames. It's possible that the 20 kW, 100 kW, and 1000 kW experimental installations created as a direct result of such collaboration will be able to turn two "minuses" into a "plus."

And yet, more often than not, the association still has to look for spheres of application for its unique products. Didn't it ever occur to any ordinary businessmen that equipment designed for a manned flight to the Moon could have some use here on the ground? It sat idle for many years, and then found application in Buran, during Buran's two orbits around the Earth. Thinking, perhaps, of the skyhigh costs, not a single design bureau deigned to "fit" the ultramodern innovations of Korolev to their own vehicles.

We can speak of the profitability of ultraexpensive equipment only when its capabilities exceed considerably the existing capabilities of today. Which is happening, for example, with the hydrogen-oxygen battery: its specific energy capacity is four- to sixfold greater than that of the ordinary lead-zinc battery and 1.5- to twofold greater than the best silver-zinc battery in existence today. The increased power saturation can, as never before, be used to good effect in mobile robots that work in radioactive areas, in aviation equipment, and in underwater vehicles.

In the underwater vehicles, by the way, the working conditions are very similar to those of space. So don't be surprised if, in the marine expanses, you see submarines that suspiciously like near-Earth satellites. Equipped with space power systems, such universal craft can effect virtually any work to depths of 6 km. Owing to that and the fact that, before the end of the century, only Russia and the United States will have oxygen-hydrogen technologies, as well as to the absolute pollution-free nature of such units (the combustion product is water) and a host of other "pluses" large and small, might it not be

certain that Energiya-produced submarines will become as well-known in the world as the association's rockets? We're not going to jump to conclusions, because work in that field is being slowed by the lack of money that is needed. "But we managed to make it into space!" says the optimistic Semenov. "And nobody has managed tasks harder than that..."

Civilian Applications for Rocket Engine Pump Technology

947Q0029A Moscow IZVESTIYA in Russian 13 Nov 93 First Edition p 15

[Article by Iosif Novodvorskiy, engineer: "There Will Be No Order. On the Other Hand, We Are Making Pumps and Turbines From Rockets"; the first paragraph is an introduction]

[Text] There are several powerful pumps in any rocket operating on a liquid propellant. Their reliable designs were worked out over the years. The first such pumps were already made when Professor Yevgeniy Levchenko, now a space technology designer, was in school.

The designing of the pumps in itself was kept secret. But time has passed and these pumps are now working in the "civilian sphere," to be sure, in a somewhat modified form. As a beginning Levchenko and his colleagues took the most important assemblies from the rockets, fine, and at the same time began to demount them. As a result excellent industrial pumps—a whole family of pumps—were designed.

These so-called axidiagonal pumps are intended for the conveyance of fluids inhomogeneous in density and viscosity, such as for the pumping of spilled oil, extraction of petroleum residues from containers and pumping of ground and clayey solutions.

Pumps of the axidiagonal pump family are more powerful, long-lived and vibroresistant than any other known pumps. In addition, the weight is small, only 35 kilograms, with a productivity of 150 cubic meters per hour, which makes them still more attractive. They already are in standard production and function excellently in the petroleum refining industry, at the oil terminals of sea and river ports. And today pilot models of pumps with a productivity of 1000 cubic meters per hour are in production, performing a unique operation which cannot be performed by other pumps, the pumping of cold petroleum residue.

Attentively examining the rockets, the designers discovered that they can "master" still another peaceful field of specialization. It appears that the turbine driving a fuel pump into motion can become the basis, the "heart," for a miniature hydroelectric power plant. Such miniature hydroelectric power plants can operate on small rivers and streams, especially in mountainous regions, where there is a great water drop and where it is difficult to string power transmission lines.

Now completion of the work is being delayed by the electricians working on the project (and the prices meanwhile are increasing), and this does not make it possible to start up two miniature hydroelectric power stations in Sochi. Investments are needed in order to get into operation these strong "babies" with a power of 30 kW each. As always, there is insufficient investment. But, unquestionably, there will be many clients for this self-contained power source operating on small rivers.

Levchenko and his colleagues are not losing hope. A defense plant is ready to produce the entire mechanical part of the electric plant. It is to be hoped that the miniature hydroelectric power plants are awaiting their hour and will come to life. In remote settlements, on farms and in military units.

Ukrainian Space Program Looking to Baykonur as Launch Site

937Q0123A Kiev URYADOVYY KURYER in Ukrainian 3 Apr 93 pp 1, 5

[Article by Volodymyr Ilchenko under the "Ukraine's Priorities" rubric: "Baykonur Facing Dilemma (Ukraine Space Agency Has Developed Space Exploration Program That Is Impossible To Implement Without Operating Cosmodrome"; photos by Stanislav Averkov]

[Text] Leninsk, the capital of the "star region" also known as Baykonur, is indeed a somewhat fantastic, "otherworldly" town. And not just because, in the words of a space classic, the way to stars has been paved through the town, - one will not find the town on a regular map. To be more precise, a map has as many as five settlements with the same name, but none of them has anything to do with the cosmodrome.

But in everything else it is quite earthly: narrow streets lined up as if following military regulations, neglected "Khrushchevka" apartment buildings, entire floors of abandoned apartments with boarded windows. Baykonur is in decay, and with it its "bedroom addition," the mocking name given to leninsk by local residents. Less and less frequently the air is shaken by the thunder of a launched rocket.

Recently a Ukrainian delegation headed by Chairman of the Commission on Defense and State Security Problems Valentyn Lemeshev arrived here. It included General Manager of the Cabinet of Ministers National Space Agency of Ukraine Volodymyr Gorbulin and several members of the Parliament. The trip was organized by the Agency and was dedicated to negotiations with the Kazakhstan party regarding joint operation of the cosmodrome. And one more important event took place - a "Zenit" rocket built by Dnipropetrovsk scientific and production association "Pivdenmash" [also known as "Yuzhmashzavod"] was launched into space.

The Ukrainian delegation was received "at the proper level." It was met by the cosmodrome Commander, Major General Oleksiy Shumilin. The next stop was at the town's only prominent building - hotel "Baykonur," where cosmonauts live before the launch and after landing. But the Baykonur schedule was such that only three to four hours were set aside for night sleep; the remaining time was spent at rocket launches, launch sites, installation and testing complexes and in negotiations and meetings...

On March 25 the Russian "Proton" was launched, and on March 26 - the "Ukrainian" "Zenit"; however, the State attribution is conventional, because both rockets had been built on orders from Union structures, in particular the former Defense Ministry. Although designers from KB [design bureau] "Pivdenne" do not like to openly praise their creation, one could feel their firm belief in its advantages over the "Proton." Their two-stage rocket puts into an Earth orbit an approximately 15 tonnes payload (the three-stage "Proton" can lift 20 tonnes), but "Zenit" is convenient for shipping and launch preparation. Its automatic system for fueling at the launch site makes it possible to fully prepare a rocket in 1.5 hours ("Proton" needs a two days preparation)....

Project for Commercial Spaceport in Papua-New Guinea Using Proton SLVs

Russian, Australian Groups Sign Agreement

947Q0030A Moscow TRUD in Russian 16 Sep 93 p 1

[Article by Vitaliy Golovachev: "Spaceport in Pacific Ocean"]

[Text] Russia, it appears, has finally been able to realize its attempts, undertaken long ago, to break into the world space market. This week the last signatures were placed on an agreement between the Australian company Space Transportation Systems and Russian enterprises, the developers and builders of the Proton space booster complex. The agreement provides for establishing the world's first private international spaceport in Papua-New Guinea. The cost of the project is estimated at 600-900 million dollars and it is planned that the first launch be carried out as early as 1998.

The Proton booster, now a quarter-century old, even today has no equals in the world with respect to reliability and other technical characteristics. Outfitted with a fourth stage (DM propulsion unit), it is capable of putting not into an ordinary orbit, but a geostationary orbit (which requires special energy expenditures), a payload of more than 4 tons. The project has received the approval of the prime minister of Papua-New Guinea, Mister Wingti, the government of Australia and Oleg Sosnovets, first vice prime minister of the Russian government.

In the territory occupied by the spaceport conditions will be ensured eliminating the possibility of transfer of booster and payload technology. Under these conditions the United States will not be able to block the entry of the company into the world market. International capital will be used in financing the project. Commercial launches promise the earning of significant profits for both Russian enterprises and foreign participants in the project.

Already in October reconnaissance work will begin on selection of an area for the spaceport. The first two million dollars should be spent before the end of March 1994. Everything is being done on a private commercial basis and not a ruble from the Russian treasury will go for this purpose.

Australian Space Transportation Systems Ltd Holds Exclusive Rights

947Q0030B Moscow NEZAVISIMAYA GAZETA in Russian 17 Sep 93 p 2

[Unsigned item]

[Text] The Australian company Space Transportation Systems Ltd and a number of Russian enterprises, developers and builders of the Proton space booster complex, have announced that they have signed a number of agreements which give Space Transportation Systems Ltd the exclusive right to establish launch and technical facilities for the launch of Proton boosters with a propulsion unit at the Pacific Ocean spaceport in Papua-New Guinea. This spaceport is planned as the first private spaceport in the world.

German Titov Interviewed on Space Program Issues

947Q0009A Moscow KOMSOMOLSKAYA PRAVDA in Russian 23 Sep 93 p 3

[Interview between Valentin Karkavtsev and cosmonaut German Titov: "There Are Many Presidents--Only One Space"; the first paragraph is a preface]

[Text] We knew them as the pioneers of the sky. But, while exploring the star world and crowned with stars, they were not inhabitants of the sky. All these thirty years they lived on the Earth: argued, made errors, shunned motion picture cameras and went about their business...

Karkavtev: German Stepanovich, this year a film was shown in the West about our space catastrophes, the details of which were carefully hidden for decades. In particular, unique frames were shown which picture the death of Marshal Nedelin during a rocket test. How come we are exporting the truth abroad, but our people, whose money created the space branch, remain in the dark?

Titov: You are right in the sense that for the broad masses there was always little information on space matters. For specialists all that the West saw was only fragments of our "star" history. Yes, the branch was kept secret. But what's new about that—that was the times in which we lived. We experienced two major catastrophes. The first was that which you mentioned. It occurred at Baykonur in 1960 in tests of a strategic missile. A group of officers and soldiers perished together with Nedelin. Some of them are buried there under a modest obelisk and parents took others away. And the second accident was already late in jthe 1970's at Plesetsk. Whether due to carelessness or due to an unhappy course of circumstances the rocket exploded and it appears that 49 persons died.

Karkavtev: And tell us, were there investigations, were the reasons found, were those responsible punished?

Titov: Things like that always were strictly handled. A commission was mandatory and a careful study of all the circumstances was made. And with respect to punishments, everything was in order: unless I am mistaken, Ivanov, head of the test site, then received a reprimand from the CC CPSU—a rare "reward." But let's return to the atmosphere prevailing in those years. How did Marshal Nedelin perish? The rocket stood on the launch pad and he sat alongside it in a small chair. Preparations were ongoing and the progress of operations was being reported to him—being that close was regarded at SOP. Later bunkers were constructed...

Karkavtsev: Do you suppose that there were special camera surveys which formed part of the film which I mentioned? And how did they get to the West—did someone decide to earn some easy money?

Titov: It is difficult for me to judge, I have not seen this film. I can only say what our routine was: the most important operations during preparation of a rocket or satellite are documented. An operation was performed—and it was all written down. And the most serious stages, in addition, were photographed by still or motion picture cameras. I do not know if such a camera survey was made on the day of Nedelin's death.

Karkavtsev: During recent years readers have been deluged with publications on the death of Gagarin. What has not appeared in such publications: Gagarin is alive, Gagarin is confined to a psychiatric ward, Gagarin was taken away by extraterrestrials...

Titov: You possibly recall that at a celebration of the 31st anniversary of manned flight I said to Gorbachev: "Mikhail Sergeyevich, use your authority to see that the scribblers writing all kinds of rubbish about Gagarin put an end to it. While we are still alive let them come to us and we will tell all." I do not know for whom these fantasies are necessary and why. But visualize one simple thing: tens of people have been engaged in investigating the death of Yuriy Alekseyevich. Is it possible that if something became known from a number of sources that such information would not then become known to a wide audience? j At that time a "black box" did not exist. One thing is objectively known: at 10 hours 29 minutes 45 seconds Gagarin asked for permission to leave the zone. A controller contacted him at 10 hours 32 minutes. There no longer was an answer... The first conclusion was as follows: Gagarin and Seregin saw a cloud, tried to turn away from it and went into a spin. But you have flown in aircraft: what is a cloud, a concrete wall? Why turn away from it? This first conclusion was refuted; I participated in preparation of a second conclusion. We wrote then: it is impossible to ascertain the real reason for the aircraft accident, but the following can be stated: the conditions were calm, an emergency situation arose suddenly and transpired rapidly, the pilots took every measure for escaping from their situation but they probably lacked time for making decisions because even the catapult equipment was not used.

Karkavtsev: You know, German Stepanovich, I still have a question: are there not many accidents for unexplained reasons? And not only with complex space vehicles, but also with such "old-fashioned" craft as the UTI-MIG-15 in which Gagarin and Seregin crashed?

Titov: This in actuality is a simple plane. But let's take a look: the reasons for most accidents are precisely determined. It has been clarified and demonstrated unambiguously why Komarov died, how Dobrovolskiy, Volkov, Patsayev and Gagarin died... There are different versions. I have my version. If it ever is proven, then we can talk about it. It would be incorrect to represent our country's cosmonautics as a chain of failures. The reliability of our rocket-space technology is an order of magnitude higher than that of the Americans, take the word of the specialist. And before proceeding to new work with the next rocket or satellite it is simply mandatory that whatever may have happened be thoroughly analyzed.

Karkavtsev: Now about reliability... The Union fell apart and the branch was divided by boundaries. Some components arrive from abroad, in particular, from the Ukraine. Would you say that the number of complaints has greatly increased as a result of this?

Titov: It is not just a matter of boundaries. Visualize that the people at our plants are not paid for several months. Naturally they leave. Quality naturally drops. And then there's the matter of jconversion. A highly qualified metal worker has made rocket equipment—suddenly he is assigned to the production of frying pans. He is really unhappy about that! With respect to complaints, quality control, thank heaven, has still been kept up: both the Division of Technical Control and the military inspectorate. Let's assume that it's components for radio equipment. There is a quality control system which evaluates not only their present-day status, but also predicts how they will hold up after a month, after a year. It is frightful to think that we might inflict a blow on these personnel as well, that we might smash the holy of holies, the quality control system... You, to be sure, do not believe it, but it is so: due to this system even today, under collapse conditions, our equipment is more reliable than that of the Americans.

Karkavtsev: Excuse me, in actuality I do not believe it. Now another question. German Stepanovich. Why in actuality has the Energiya-Buran program been put on ice? Indeed, insofar as I understand it, the American Shuttle program was the new word in cosmonautics and we responded to it with the Buran.

Titov: Has it ever come to you as to whether it is always necessary to invent new words if there is a possibility for explaining something with old words? No, I am not a reactionary. Once at Baykonur I chanced to receive an American military delegation. I asked: "Why do you have the Shuttle?" They answered: "In order to remove satellites from orbit, return them to the Earth and modernize them." All this is nonsense. Think it over a bit, why would they remove them?

Karkavtsev: Let's assume that under weightlessness conditions we produce some product which must be transported periodically from orbit to the Earth. A "shuttle" is necessary for this purpose.

Titov: Excuse me, as a specialist that strikes me somewhat funny. But let's return to the American version. The removal of satellites from orbit and their repair is an absurd undertaking. For a satellite serving in space for 7-10 years you will not find even a single plug, a single spare part; during this time the technology has gone way ahead. The Challenger fell? It perished. How many billions were necessary in order to restore the program? And how many years did they lose on this? One thing is clear to me: a booster for one-time use is considerably cheaper—at this time. Second, it is in standard production.

Karkavtsev: If all this is so evident, why would the pragmatic Americans undertake this program?

Titov: I have my point of view and incidentally I expressed it to the Americans. Let's recall: they had the Mercury, then the Gemini, then the Apollo. And when they understood that the Soviets had gone way out ahead (in particular, in the field of manned flights), then Kennedy said: our national objective is to be the first on the moon. The Apollo project was carried out, they landed on the moon, flew around it six times, it seems, and brought back a heap of "moon rocks." And then what? A potential had been created: industry, design bureaus, work places. They began to make the Shuttle. They did so. Then what? Then, if you recall, that SDI monster was born. Why? It's all very simple: in order that the potential not be lost, that conversion not take place, but that it be kept for new space development work. The idea of Star Wars was then widely ballyhooed. Our military institutes very attentively examined all these concepts and concluded: it is impossible to create a strategic defense initiative system. Take still another circumstance into account. In America there is an ironclad rule: if in a state which you represent in congress as a senator there is a loss of even a few jobs tomorrow you are no longer a senator.

Karkavtsev: But indeed they, like us, could pass along the route of one-time use boosters, along the path of creating orbital stations—cheaper, more practical, more reliable. However, their Skylab program, identical to ours, passed away ingloriously.

Titov: And why, really, "ingloriously." And perhaps our Salyut passed away gloriously? No, in no case do I want to demean the "Salyut" program. Volodya Titov, my namesake, lived for 366 days, a leap year, in space: such had not happened prior to the Salyut. Due to the Salyut we organized supplying of orbital stations—that about which Tsiolkovskiy had dreamed. But looking at the big picture, all this was a buildup on itself. There was nothing gained. The Americans are more practical people. They concluded that the Skylab was bringing

nothing new. Let the Russians fly, let them waste money, we will find a way to make use of their results.

Karkavtsev: The British have a saying along those lines: "Why do that which the Germans have done already-"...But OK, if everything was clear to us about the "shuttle," why, in your opinion, did we undertake the Buran?

Titov: Well, first of all, the idea of a "shuttle" did not come to us after the Shuttle. The Spiral program was already developed at the Mikoyan Design Bureau in 1963. At that time they designed the Dinosaur, which grew into the Shuttle. In our country, unfortunately, the Spiral was not transformed into the Buran, although the development work of the Mikoyan Design Bureau also was more original. Incidentally, there is still another detail which does not speak to the advantage of a "shuttle." At one time the Americans ballyhooed: the delivery of a kilogram of payload in the Shuttle will cost 150 dollars, Now it is 3500 dollars and there is no tendency to a decrease.

Karkavtsev: And in our country?

Titov: Let's make some calculations. Although right now it's unclear what money these calculations should be made in. I declare in the most responsible way that it is cheaper for us. Well, let's take "give or take" prices. We put about three tons into a stationary orbit. The rocket then cost 5 million, plus the satellite itself, about 8 million.

Karkavtsev: We divide thirty by three... About four thousand of these "real" rubles per kilogram of payload. Well fine, but why did we, coming to the idea of the Buran, not pull the development work of the Mikoyan Design Bureau from the shelf?

Titov: That's very simple. One military director of the "shuttle" project wrote: "This is a fantasy." The program was shut down. Then, when the world learned about the Shuttle, another military director said: "Why do the Americans have this and we do not? We should!"

Karkavtsev: Have we finally put the Energiya-Buran program on ice? The general Designer Gleb Lozino-Lozinskiy asserts that at the NPO Molniya the intention is to "reoutfit" the Buran into the MAKS—a multipurpose aerospace system—and already in the coming year it will be exhibited at a show in Germany. According to other information, the government has virtually frozen financing for the Buran.

Titov: Frankly, I do not know exactly. I heard that the decision was made to shut down the program. I admit that my attitude toward the Buran has always been negative, although I had to carry out the decisions which were made. The only thing that brings satisfaction is that on this "little bird" we created and finalized an automatic landing system. Which, very regrettably, has not been introduced into our valorous civil aviation.

Karkavtsev: German Stepanovich, from where will we fly in the future—from Baykonur, which seemingly is no longer ours, from Plesetsk, which is not very convenient geographically, or must a third variant be sought?

Titov: I would like to believe that this stalemate will soon end. Space cannot be divided up. Baykonur has been looted and the looting is continuing. The next stage will be its restoration. There is no need to establish a new cosmodrome at our latitudes. At Plesetsk we have excellent launch facilities and a launch pad for Zenits is being constructed. The only thing which cannot be shuffled to Plesetsk from Baykonur is the Proton launch pads. But, I repeat, common sense should be first and foremost. Indeed, it comes down to anecdotes. The chief of space units orders Zenits (they are constructed at Dnepropetrovsk) and they tell him that payments cannot be made: coupons are used in one place and rubles in the other. Assume that even the village of Zakhlyupanka has its own president, but that does not affect economic relationships. That is the nerve which feeds our entire life.

Karkavtsev: What we had was a unified state cosmonautics with its administrative pyramid. And then everything fell apart, every self- respecting company rushed to the foreign market to earn foreign exchange. And the Americans saw this and began underhandedly and methodically to block their competitors. As in the case with cryogenic engines...

Titov: In 1955 we began the construction of Baykonur—10 years after an extremely severe war. The strength was found to develop nuclear weapons and rocket technology, to build cosmodromes and factories. Because undertakings were on a national scale. Well, things are different now. Space is a market. And we have something to offer. These same cryogenic engines are unlike any in the world. But why are forbidden to sell them? Why do we so attentively listen to what is "whispered in our ear?" But I want to say that it is necessary to enter the market with a well-organized command structure, otherwise we will lose out in the future.

Karkavtsev: This year a series of publications appeared whose central figure was Colonel General Ivanov, chief of the military space forces. He was criticized for being involved in commerce, which is incompatible with a general's rank...

Titov: It seems to me that this was a large-scale attempt to compromise the man.

Karkavtsev: But where could this come from? Is it from the fact that in our country military and civilian cosmonautics do not get along together very well?

Titov: Scarcely. When I served in space units there was no divergence in views with the civilians. Now, I agree, there is strain in the relationship. But I do not think that it gave rise to the mentioned publications. I always spoke out for space objects to be used sensibly. Here we have satellites for military communication. Each of them has

several radio communication trunks. If a pair of trunks has failed, the military people asked that the "crippled" satellite be replaced by a new one. But four trunks are in operation!

Karkavtsev: An auction is to be held in America in December. They say that personal items of cosmonauts will be offered there. Is it true that you will offer your fork there?

Titov: Something like that. They made me the proposal that I put up on auction those things which had been in space. I have virtually no such things. I already gave my watch to Walter Ulbricht in 1961 at the time of a visit to the GDR. But the fork and opener—I took them with me in the descent module. I returned home and drove the car to a storage structure where they laid for thirty years. You know, later it was written in the NEW YORK TIMES as if the cosmonauts at Zvezdnyy moved with reckless abandon to hand things over to the auction. When I read that I wanted to recall my things. Somehow all this was unworthy and shameful. And I would not have thought about this fork if you had not asked.

Karkavtsev: You are now retired, German Stepanovich?

Titov: Yes, already for two years now. I thought, I'll go into retirement and busy myself with my archives: there were entire suitcases stuffed full of unsorted papers. Where is it...?

Karkavtsev: And what is the character of your work now?

Titov: First, I am president of the International Kosmoflot Center—you mentioned it, which is an association of organizations which is carrying out several space projects. My second position is deputy chairman of the council of the Russian Aerospace Complex Conversion Center. So that without space there is no place to go. It will live on without us, but we cannot live without it.

Russia Prepares for Space-Based Ecological Monitoring With U.S.

93WN0646A Moscow ROSSIYSKIYE VESTI in Russian 24 Sep 93 p ii

[Article by Vladimir Karasev, secretary of the Ecological Policy Council under the president of the Russian Federation: "Earth: A View From Space. On Cooperation Between Russia and the United States in the Area of Ecological Monitoring"]

[Text] While the Chernomyrdin-Gore commission was working in Washington, both sides expressed special interest in cooperating in the area of ecology and solving problems of protecting the environment through space monitoring. A proposal was formulated for the departments of Russia and the United States to join forces for improving systems for gathering and processing space information and to assess the possibility of its use by the world community.

In keeping with the joint declaration signed by Chernomyrdin and Gore for development of cooperation in the area of ecological monitoring of the earth from space, for the next meeting of the Chernomyrdin-Gore commission, planned for November in Moscow, it will be necessary before November to prepare and submit Russia's proposals regarding the aforementioned problem, which are to be coordinated with the corresponding departments of the United States.

A. Yablokov, adviser to the president of the Russian Federation regarding issues of ecology and health protection, called a working conference to discuss these issues on 10 September. Participating in it were representatives of the Council of Ministers-Government of the Russian Federation, the Ministry of Defense, the Ministry of the Environment and Natural Resources, the Ministry of Agriculture, the Ministry of the Economy, the Ministry of Science and Technical Policy, the Ministry of Foreign Affairs of Russia, the Russian Space Agency, the Russian Federal Geodesic and Cartographic Service, the Russian Federation Committee on Management of Water Resources, the Russian Federal Forestry Service, the Russian Federation Committee on Land Resources and Land Management, the Russian Federation Committee on the Defense Industry, the Russian Federation State Committee for Geology and the Use of Mineral Resources, the Russian Federation State Committee on Civil Defense, Emergency Situations, and Recovery from Natural Disasters, the Russian Federal Service on Hydrometeorology and Environmental Control, and the Russian Academy of Sciences—that is, not only the consumer departments but also the producers of information.

During the discussion, they earmarked potential clients of space information, the main areas for cooperation, and also model composition and regulations for the activity of the work group for the formation of preliminary proposals which will be submitted to the American side for coordination.

Proposals from the American side were discussed.

According to the expert assessment, this cooperation will make it possible with a relative reduction of expenditures on space programs by both countries separately to achieve a significant increase in the volume of information that is received and processed, which, in turn, will lead to a rapid breakthrough in technologies and increased effectiveness of measures for ensuring ecological safety in both countries.

It is anticipated that Russian carriers and American equipment and instruments will be used, and the most progressive technologies for processing and using the information that is received will be used in the joint programs.

From among the most significant new areas for the use of the data from ecological monitoring of the earth from space, it is possible to name the following:

observing the development of impending ecological disasters in a timely manner;

determining the borders of zones of ecological disaster and ecological trouble;

reacting immediately to the appearance of emergency situations;

tracing geological processes;

monitoring land degradtion;

cartography;

prospecting for new deposits of minerals and monitoring old ones;

exploring surface and underground waters in order to determine the degree of their pollution, erosion of shores, overgrowth, and flooding of coastal territories;

observing moving ice on rivers;

remote exploring of the condition of forests for entomological damage, pests, diseases, and pollution;

predicting productivity, assessing the heat balance of the soil, the sanitary condition of planted areas, effects over time on the condition of plowed land and agricultural land from technology-generated pollution linked to the activity of large industrial facilities;

monitoring the condition of territories surrounding the sites of enterprises for destroying means of mass infestation, including chemical weapons;

ultra-long-term weather forecasting;

life support for passenger flights, and so on.

The need to finance this work not only from the state budget but also with funds from the users was emphasized.

It was noted that this was the first time in history that the question of interstate cooperation in this area was raised at such a high level and that we are moving toward this cooperation not with our hand held out but with a significant contribution. The activity of the Chernomyrdin-Gore commission coincided in time with the intention of states of the former USSR expressed at the last meeting of foreign affairs ministers to go to the UN with a joint appeal for consideration of the question of ecological monitoring at the session of the General Assembly.

M. Tolkachev, deputy minister of environmental protection and natural resources of the Russian Federation, is in charge of the work for preparing the Russian proposals.

New U.S.-Russian Space Station Plans Outlined

947Q0008A Moscow NEZAVISIMAYA GAZETA in Russian 29 Sep 93 p 6

[Article by Anatoliy Zak: "New Appearance of Russian Space Program. It Is Helping To Find American Partners"]

[Text] These days intensive work is underway in the principal think tanks of Russian cosmonautics which is shaping a completely new appearance of the Russian space program for the coming decades. In essence, reference is to the merging of promising Russian projects in the manned flights field with similar American development work and on their basis the creation of an international settlement in space. A green light was given for these efforts at a highest political level during the recent visit of the Russian prime minister Viktor Chernomyrdin to the United States and his conversations with the American vice president Albert Gore.

In the course of the session of the Russian-American commission on energetics and space held in Washington, five individual documents were signed or agreed upon. Two of them call for the development of long-range cooperation in the field of aeronautics and scientific research on the Earth and in space (it is proposed that specific projects be approved during a visit of vice president Gore to Moscow before the end of this year). A memorandum of mutual understanding on problems involved in the nonproliferation of rocket technology, in general confirming the intention of Russia to adhere to the corresponding international legislation, at the same time makes a statement concerning the inviolability of the developing cooperation of the CIS rocket-space branch.

The efforts of Russia to enter the services market for the launching of commercial satellites were completed by an agreement establishing a quota which will enable Russia to win the competition for the launch of 12 satellites into stable orbit using eight Proton boosters prior to the end of the current decade. This number does not include the already concluded contracts for the launching of the INMARSAT-3 satellite in 1995 and three groups of six low-orbit satellites of the Iridium system, each of which will bring Russia not less than 60 million dollars, using Proton boosters. The conditions of the contract with INMARSAT provide for the receipt of the first payments already in this year. The implementation of all the allowed launchings will yield an estimated 600-700 dollars. In commenting on this agreement, Yuriy Koptev, director of the Russian Space Agency (RSA), stated: "It is to be regretted that we are entering into this market under quota conditions, but we have simply no other recourse."

The possibility of using Russian boosters is now being examined by the Loral company. The INMARSAT consortium is selecting a booster for the three satellites, and

finally, the Motorola company to all intents and purposes is ready to use the Proton for launching two additional groups of Iridium satellites.

However, the greatest breakthrough in the course of the Washington conversations was attained in the manned space flight field. A joint document signed by both sides provides for a three-stage plan for the gradual merging of the space programs of the two countries. In the first stage (up to late 1997) four American astronauts will participate in long-term expeditions in the Mir station, with a total flight time amounting to two years. In addition, promising scientific instruments from the United States must be installed in the Russian Priroda and Spektr modules, which already for several years have been earthbound due to problems with outfitting them with instruments. The United States, as is stated in the joint document, will provide compensation for the services of Russia in the amount of 400 million dollars for four years.

The appropriation of the first 100 million for this purpose in the 1994 fiscal year, beginning in the United States on 1 October of this year, has already been approved by the American congress. As a comparison it can be said that the entire Russian space budget for 1993 is 81 billion rubles, that is, less than 80 million dollars. Although some representatives of the Russian rocket and space industry caution against excessive hopes for foreign monetary contributions, the financial support arriving from abroad should play a decisive role in efforts to bring the branch out of its very deep financial crisis. According to RSA data, despite the fact that the percentage of expenditures on space in the Russian state budget in comparison with the preceding year increased from 0.23 to 0.44%, state contributions amounted to only 8 billion rubles of the 21 billion expended during 8 months of the current year on the manned program. The remaining sums were received from the commercial activity of Russian space centers, including advance payments for impending projects. Many key rocket industry enterprises are on the brink of bankruptcy. For example, at the Progress plant at Samara, where the debt stands at 14 billion rubles, the production of Soyuz boosters has in essence ceased. As a result, the launch of an unmanned supply ship to the Mir station, intended for 15 October 1993, cannot take place on time. This time the leaders of the Russian space program are hoping to "borrow" a booster from the inviolable reserve of the military space forces. However, during the last two years these reserves have decreased by a factor of three and as a result the question may arise of a breakdown in functioning of the Mir station in a manned mode. It is known that the former rules of the military space forces required that there be an untouchable reserve of rockets ensuring a yearlong program of rocket launches. Now, however, only a four-month reserve is available. According to RSA data, at the present time there are only two rockets at the disposal of the directors of the Russian manned program.

For the time being, happily, the crew's work in orbit is going in accordance with plan, while in the United States a Russian cosmonaut is winding up training for flight aboard the Shuttle late this year. The inclusion of Sergey Krikalev in the crew of the American Shuttle, until recently regarded by many as a purely ceremonial event, now is being represented only as the first step on the path to interadaptability of the space systems of the two countries. In mid-1994 Krikalev's backup, Vladimir Titov, will participate in another Shuttle flight during which the Shuttle will approach the Mir to a distance of 100 meters. According to Viktor Blagov, deputy flight director of the Russian control center, during the course of this operation plans call for perfecting all the approach maneuvers so that in June 1995 there will be a reliable docking of the Shuttle which will deliver to the Mir the next long-term expedition of two Russian cosmonauts. By that time one American astronaut, launched aboard the Soyuz, will have spent 91 days in the Russian orbital complex. After a five-day joint flight the Shuttle will take the two Russian cosmonauts and their American colleague from orbit for undergoing a post-flight examination at the NASA center at Houston.

Already in November of this same year the American Shuttle will again arrive at the station as a transport ship for supplying and servicing the Russian orbital complex. Among other things, plans call for replacing a pair of solar cells on the base unit, degraded by radiation, or one of the station modules. In the words of V. Blagov, one such voyage will make it possible to save three Progress ships. In addition, for the first time it will become possible to return to the Earth such unwieldy loads as the gyrodyne of the orientation system or a storage battery for detailed investigation of the reasons for their malfunctioning.

One or two Shuttle flights per year will be made in the Mir station up to the end of its operation in 1997 when the second stage of Russian- American cooperation will begin.

Already in March 1993, when the crisis of the American program for a permanent orbital station had just heated up, the NPO Energiya and the RSA proposed to NASA that the Freedom project be combined with Russian plans for building the Mir-2 station, thus solving financial problems in both countries. Since that time NASA, going over a great many of its own variants for reducing the cost of the project, has not been able to "drive" it finally into the narrow framework of the anticipated budget restrictions. In such a situation the turning to Russia with its unique experience in the operation of orbital stations and its inexpensive rocket capabilities seemed to be the last radical solution. From the political point of view this required from the Americans sharing of their role as absolute leaders within the framework of the Freedom project. And now, when the necessary will has appeared at a higher level, prior to 1 November 1993 the specialists of the two countries must come into agreement on the technical details of the unprecedented undertaking. The arrival in Russia of a group of approximately 30 representatives of NASA centers and American industry for solution of these problems is expected this week.

The first compromise was the choice for the future station of an orbital inclination of 51 degrees, accessible for the transport vehicles of both countries. For Russia this means loss of the possibility for observing from the station considerable regions of the country lying to the

north of 51 degrees and giving up flights to the station from Plesetsk cosmodrome, which in principle were possible when using an orbital inclination of 65 degrees planned for the Mir-2 station. The United States, in turn, was forced to agree to a considerable decrease in the lift capacity of the Shuttles in comparison with their traditional orbital inclination of 28 degrees. As a result, the largest manned modules of the Freedom station, designed in Japan and the European countries and intended for launching by the Shuttle, are too heavy for launch into the new orbit. In the event that the necessary modifications of the Shuttle accelerators are not made for financial reasons, the ESA and Japan will probably turn to the use of Russian Proton boosters.

Under the new plan the construction of the Russian-American station will begin with a launching of the base unit designed for the Mir-2 station by a Proton booster from Baykonur in October-early November 1996. Then a chain of three docking modules launched by Zenit rockets will be added onto the front docking unit of the base unit. It is destined to become a singular nodal crosspiece of the station to which the Soyuz and Progress transport ships and their enlarged modifications will be docked, as well as Shuttles, subsequent modules and an enormous beam structure supporting the power and engine systems of the station. By late 1997 the orbital complex should include the American scientific laboratory designed for the Freedom.

The third stage of the Russian-American plan, which should be realized by 1999-2000, provides for transforming the station into a truly international station. By that time the orbital settlement should incorporate the rich heritage of the Freedom project, including European and Japanese laboratories, a Canadian robot-manipulator and new energy systems. Thus, the realization of all these stages of this large-scale Russian-American plan should not inflict losses on any partners of the United States and Russia from third countries.

In the third stage additional Russian modules, planned for the Mir-2 station and launched by Zenit boosters, will be docked to the station. In addition, the American partners showed a considerable interest in the proposal of the Khrunichev Center to use in constructing the station an interorbital transfer vehicle constructed on the basis of the transport supply ship of the Chelomey Design Bureau (now the NPO Mashinostroyeniye).

The second and third stages of the Russian-American plan, like the first, will provide for payments by the United States for the services of Russian enterprises. According to RSA estimates, the total sum of these payments may be 600-700 million dollars. Nevertheless, RSA representatives emphasize the equal-rights participation of Russia in the project, cautioning about the need for our country to assume the financial obligations following from the international status of the future station. In return Russia will receive the right of access to the resources of all station elements and the possibility of receiving profit from the commercial services performed aboard it.

Russian-U.S. Group Offers Space Launches Using Sea-Launched Missiles

947Q0020A Moscow MOSCOW NEWS in English No 40, 1 Oct 93 p 8

[Article by Gherman Lomanov: "Americans To Join Missiles' Recycling Project 'Priboi'"]

[Text] The implementation of the START I and START II treaties will call for an immense input on Russia's part. To compensate in part for the state's expenditures on the elimination of strategic arms, a vast commercial programme has been drawn up to be known as "Missiles—Housing." All work on the recycling of sea-based missiles has been entrusted to the association RAMCON ("conversion of submarine-launched ballistic missiles").

MN File

The idea of RAMCON's establishment was suggested by Igor Velichko, general designer of a state rocket centre known as the "Academician V.P. Makeyev Design Office," and supported by Naval command. In keeping with the RF government's Resolution No. 820 dated October 22, 1992, on the implementation of the "Missiles—Housing" programme the association will take over (as they are phased out of service) the missiles, ship complexes and their equipment to be eliminated, as well as missiles and equipment whose terms of guarantee have expired.

In the period when the START I and START II treaties will be in force (between 1997 and 2002) it is envisaged to utilize upwards of a thousand sea-based ballistic missiles SS-N-6, SS-N-8 and SS-N-18. Some of which after being re-equipped will be used for commercial launchings which RAMCON sees as the main source of submarine-launched ballistic missiles (SLBM). To the same use will be put the re-equipped missiles SS-N-20 and SS-N-23 (PCM-52 and PCM-54) with expiring operational terms which do not come under jurisdiction of the START I and START II treaties. This orientation in RAMCON's activities is envisaged in the comprehensive programme for the reduction, elimination and utilization of SLBMs and the systems of sea-based rocket complexes approved by RF Minister of Defence Pavel Grachev on June 11, 1993.

Of course, it is not easy to break into the space market—practically the whole of it (c. 1.5 billion dollars a year) has been divided among the European consortium Arianespace (56%) and the American firms Martin Marietta, General Dynamics and McDonnel Douglas (33%). Russia's share despite possessing 60% of capacities for commercial launchings, comes to a mere 3% and whilst the schedule for launchings has been fully signed up until 1995—there are roughly 2.5 times more proposals for putting a satellite into orbit than the applications accepted by firms dealing with launchings.

Nevertheless RAMCON thinks highly of the re-equipped SLBMs' competitive power. There are at least three

reasons for optimism. First, the V.P. Makeyev engineering design office possesses a broad spectrum of different carriers (see Table) making it possible to offer customers a diverse range of services. Second, when launched from the surface ofwater (project Priboi) the re-equipped sea-based missiles do not require launching pads and it is possible to launch satellites from any latitude and along any trajectory. Third, preliminary estimates have shown that RAMCON is in a position to ensure its prices for launchings at 7.5% below world prices and amass a substantial profit.

The promising nature of this sector of space services is also corroborated by the fact that RAMCON has the benefits of active cooperation with the US corporation Sea Launch Investors which on August 29, 1993, signed a contract on the establishment of a joint corporation Sea Launch Service. The SLI is headed by Admiral Thomas Moorer, Chief of Naval Operations, a professional who can better appraise the advantages of Russian SLBMs. Notably, Russia alone has optimized the launching of liquid-propellant rocket engines in water—this is essential because the Priboi rocket must be launched not from submarines or surface ships but directly from sea surface. The potential of the enterprises belonging to the association and engaged for more than 30 years in the development and manufacture of SLBMs, has been highly appraised by rocket developers the world over.

All financing for the Priboi project comes from the funds the Sea Launch Service corporation receives from domestic and foreign investors.

The Missile Space Systems of the V.P. Makeyev Machine-Building Design Office

Carrier rocket	Payload	Basic characteristics	
ZYB	Biotechnological Efir block	Probe mass	650 kg
		Mass of biotechnological installation	80 kg
		Duration of the weightlessness phase up	to 17.5 min
	Sprint technological block	Probe mass	450 kg
		Mass of technological installation	100 kg
		Duration of the weightlessness phase up	to 20 min
VYSOTA VOLNA	Efir block	Duration of the weightlessness phase up	to 30-36 min
	Sprint block	Duration of the weightlessness phase	36-44 min
SHTIL-1H	Equipment of foreign firms	Mass of payload put in orbit with altitude	200 km-430 kg 700 km-185 kg
		Volume of payload	1.5 cu m
	Space communication Satellites	Altitude of orbit	500-700 km
		Speed of transmitting information	32 cu.sec
		Number of sputniks in the system	32-48
		Mass of the sputnik	250-300 kg
SHTIL-2H	Equipment and sputniks of foreign firms	Mass of payload, put in orbit with altitude	200 km-265 kg 700 km-90 kg
		Volume of payload	3.0 cu m
SHTIL-3H	Equipment and sputniks of foreign firms	Mass of payload, put in orbit with altitude	200 km-410 kg 700 km-220 kg
SHTIL-3A	Equipment and sputniks of foreign firms	Mass of payload, put in orbit with inclination of 0(90) degrees and altitude	200km-950 (620)km 700km-730 (430kg)
		Volume of payload	3.6 cu m
RIF-MA	Equipment and sputniks of foreign firms	Mass of payload, put in orbit with inclination of 0(90) degrees and altitude	200 km-1,500 (950) kg 700 km-1,200 (650) kg
		Volume of payload	10 cu m
PRIBOI	Equipment and sputniks of foreign firms	Mass of payload, put in orbit with inclination of 0(90) degrees and altitude	200 km-2,400 (1,840) kg 700 km-1,930 (1,430) kg 6,000 km-200 kg
		Volume of payload	4-10 cu m

Note: Zyb, Vysota and Volna missiles are launched from submarines; Shtil-1H, Shtil-2H and Shtil-3H start from a ground launcher near Arkhangelsk; Shtil-3A, Rif-MA from AN-124 and AN-225 carrier-planes. Zyb, Vysota and Volna are put on quasi-vertical trajectories (ensuring weightlessness in the range of 10-4-10-3 degrees), others-on orbital trajectories.

Good Cooperative, Commercial Prospects Seen for Russian Space Sector

947Q0007A Moscow ROSSKIYSKIYE VESTI in Russian 6 Oct 93 p iv

[Article by Valeriy Andrianov: "Dollars—in Space. At Least It Is Possible To Earn Them There"]

[Text] Beginning with the time of launching of the first artificial satellites space became a competitive arena of the two superpowers: who would be the first to make a manned flight, who would be the first to walk on the lunar surface? But the times of confrontation have been replaced by an epoch of businesslike cooperation between Russia and the United States, including in the space research field. For Russian cosmonautics this is not only of political and scientific, but also of great economic importance. It is no secret that the Russian space industry is close to a crisis stage. At the beginning of the year 72 billion rubles were allocated in the budget for experimental-design work and 9 billion for capital investment. But up to now only 37 and 3.5 billion respectively of these rubles have been received. At the same time the prices for the products of technology have increased by a factor of 3.5-4.6. Money does not suffice even for that which is most necessary. Even under the program for joint flights not more than 43% of all the expenditures are at state expense. The remaining sums must be earned in the international space market, in cooperation with other countries. But on what other countries can the Russian space industry rely? Not rarely the complaint is heard that Russia has lost its influence in third countries. Meanwhile, some of these are developing their cosmonautics and require technical assistance. It is the opinion of specialists that they cannot be shunted aside, but nevertheless cooperation with them cannot solve all the problems of our builders. For example, in Argentina only 60 million dollars have been allocated to space, in Brazil—100 million, in India—200 million. In order to attain significant results Russia must establish firm bonds in the cosmonautics sphere with the well-developed countries. As is well known, all the members of the world community expend on it a total of 24.5 million dollars annually. The United States accounts for 14 billion of these, the European Space Agency—3.5 billion, Japan—1.5 billion, and Germany and France—1.3 billion each. And these countries are interested in joint research with Russia and are ready to invest money in our space industry. Perhaps a new stage in international space cooperation opened up after a visit of the prime minister Viktor Chernomyrdin to the United States and signature of a Russian-American declaration. The joint work of the Russian Space Agency and American NASA will involve three stages. As is well known, the idea of joint space flights developed even during the cold war. The first of these, with the participation of the Soyuz and Apollo ships, took place in July 1975. Now, after almost 20 years, this work will be continued. Under the Mir-Shuttle program, early and late in 1994 there will be flights of Space Shuttle crews in which Russian cosmonauts will be included, but in early March 1995 a replacement crew of two Russian cosmonauts and one American astronaut will be delivered aboard the Soyuz transport ship to the Mir orbital station. They will spend three months in the station. Flight preparation of the American candidates will begin at the Cosmonaut Training Center in early 1994. In addition, in early June 1995 plans call for the docking of the American Atlantis ship with the Russian Mir station. The ship's crew will consist of four astronauts and two of our cosmonauts. They will replace the station crew which will be delivered there in March 1995. The joint flight will last five days, during which plans call for studying the physical condition of the entire crew. Thereafter two Russian cosmonauts and an American astronaut will return to the Earth and will undergo medical examinations at the NASA Johnson Space Center. Up to 1997 plans call for carrying out three or four flights of Americans aboard our ships. The total time of presence of American astronauts in orbit will be two years. Due to this cooperation the Russian space industry over the course of 3-4 years will receive 400 million dollars. Prior to 1 November a package of projects and contracts for the first year in the sum of 100 million dollars will already be prepared. But the first stage, nevertheless, is only preparation for deeper and larger-scale cooperation between NASA and the Russian Space Agency. In the future lies the creation of the first international orbital station in the history of mankind. The Mir station will become the prototype for it and the base unit will be constructed in its image. It will also dock with modules developed in the United States, Japan and Europe. It is the opinion of Yu. Koptev, the general director of the Russian Space Agency, and Yu. Semenov, general director of the NPO Energiya, that the station will be able to receive a crew of three persons, and by the year 2000—nine. Assembly of the station in orbit will require from 16 to 20 flights of American Space Shuttles and Russian Soyuzes. In the third stage of RSA- NASA cooperation the station will be further outfitted with Russian and American equipment. A Canadian space manipulator will be used in docking the modules. What will Russia gain from this grandiose project? In addition to new scientific data, enormous investments will be made in the national economy. In the second and third stages of the program, that is, in 1996-2000, we will be able to receive 600-800 million dollars. An impressive sum. All the more true if one recalls the present-day totalbudget for our country's cosmonautics. But one also should not forget another important source of hard currency income: the commercial launching of satellites. Earlier this method for earning dollars was unavailable for Russia due to political reasons. Now, however, we have received the opportunity to participate in 8-12 bids for satellite launches. And in four of them the load may not be one satellite, but two at the same time. If it is taken into account that the launch of one object into orbit costs no less than 60 million dollars, this means that Russian cosmonautics in the foreseeable future will be able to receive 600-700 million dollars. Indeed, there is no doubt as to the competitiveness of our Protons in international bids. We have already won one of them. In November 1992 the INMARSAT consortium announced its decision to launch a satellite of the INMARSAT-3 model with a Russian rocket. The Russians offered the most favorable conditions. The cost of the launch will be 36 million dollars. However, if it was launched by an Atlas booster the cost would be 52.5 million and a launch with an Ariane booster

would not cost that much less. Thus, Russian rocket construction is able not only to support itself, but also to contribute hard currency to the national treasury, needingit so badly. If there were only conditions for real international exchange, for entry into the external market. Many Russian design bureaus and scientific production associations have already successfully used their right to conduct independent foreign economic activity. For example, the Khrunichev plant has signed a contract with the American Motorola Satellite Communications company. This company is the principal developer of a project for the low-orbit Iridium system, including 66 space vehicles, 21 of which the company plans to launch by means of Protons, constructed at the Khrunichev plant. Russian builders will implement this contract in collaboration with their colleagues from the American Lockheed Company, which is the principal Motorola contractor for this project. The RimSat company also has taken an interest in the use of Russian satellites. A contract valued at 150 million dollars provides for putting seven communication satellites into orbit over the Pacific Ocean: three of the Gorizont type and four of the Ekspress type. Specialists from the NPO imeni Lavochkin also have not remained aside from the space market. They are developing modules for the Russian- American Mars 94 program. It provides for study of the surface and atmosphere of the "red planet," as well as search on Mars for elements capable of causing the corrosion of metals. The experiment will make it possible to determine the materials which are best suited for the fabrication of spacesuits for future manned flights to Mars. Only several years ago the participation of Russian scientists in all these projects was almost impossible. Joint development work for our cosmonautics was the exception rather than the rule. Possibly therein lies one of the reasons for the calamitous situation in which the branch has found itself. But the understanding gradually came about that cosmonautics is not only an element of national prestige, but also an excellent method for earning foreign exchange. Recognizing the unprecedented scales of the brain drain, the politicians possibly have become somewhat sobered. And now it is necessary to create all the jconditions so that scientists can earn money not in the West, but within the country. Both science and the economy will gain from this, as well as national prestige, for whose preservation we struggled so hard, making all our space achievements secret.

Commercialization of Space Viewed in Light of U.S. Experience

947Q0018A Moscow DELOVOY MIR in Russian
No 205, 18-24 Oct 93 p 13

[Article by Vladimir Terekhov, RISI: "Commercial Cosmonautics in the Formation Stage"; the first paragraph is an introduction]

[Text] The terms "commercialization of space activity" and "commercial cosmonautics" have already had currency in our country for about 10 years, but unfortunately for the time being have not been associated with significant Russian progress in this field. One of the reasons for this, it seems, is related to the not entirely clear understanding in our country, including in government agencies responsible for the development of cosmonautics, of what is really meant when use is made of the adopted English word combination "Commercialization of Space." The meaningful context of the mentioned terms, evidently, is easier to explain through answers to the three questions: "What?", "Why" and "How Does All This Relate to Us?"

What?

Our understanding of the term "commercial cosmonautics" necessarily must reflect the general economic problems of the country, in particular, an acute need for receipts of foreign exchange. And their source is civilian and military space systems, developed in their time for purposes not having any relationship to the development of commercial operations in space. The opportunity to transfer some sum in hard currency to the national treasury is an entirely worthy objective and successes in achieving this must be welcomed in every way possible.

It only must be remembered, for example, that the contract under which the Khrunichev plant is launching one of the satellites of the INMARSAT consortium has a remote relationship to the process of commercialization of Russian cosmonautics. Instead this deal falls in the category of foreign trade activity of state agencies. In actuality, the state (Russia) through a governmental agency (Khrunichev plant) is performing some services (satellite launch) to a consortium formed of 50 or more countries on the basis of intergovernmental agreements. What commerce and entrepreneurship is involved here? Other projects about which we have recently learned will be carried out on the basis of intergovernmental agreements.

Deals of the type of that which was mentioned above up to the mid-1980's also were concluded by NASA, a government agency responsible for the civilian space activity of the United States. The price for the transport services supplied by NASA to a client (including foreign) included the cost of manufacture of the booster by private companies and expenditures associated directly with its launching. In conformity to American legislation NASA could not extract any profit from this deal and in the United States it never occurred to anyone to classify it as commercial space activity.

The situation changed fundamentally after adoption of the law on commercial space launches (Public Law 98-575) by the congress in 1984 and subsequent presidential directives. In accordance with these acts a client desiring to use space transport services in the United States must now directly, bypassing NASA, make a deal with one of the three American private companies which construct the principal American boosters (McDonnel Douglas, General Dynamics, Martin Marietta), which obtained the opportunity for engaging in business in this field.

In the course of commercialization there is a fundamental change in the nature of the interrelationships among governmental organizations and private companies. Earlier in the implementation of government space programs a private company filled an order from a

government agency for money from the government. The contractor was virtually free of the element of financial risk because the government covered all the expenditures borne by the contractor in the course of filling the order. However, in the implementation of a commercial project (related, for example, to developing equipment for producing ultrapure semiconductor crystals in orbit and their subsequent sale in the open market) a private company not only receives the profit, but also takes on, partially or entirely, the risk of a possible commercial failure of the project.

The process of commercialization of cosmonautics met with different difficulties and by no means corresponds to the optimistic predictions of the mid-1980's. There were predictions, for example, of an enormous increase in profit in commercial cosmonautics by the end of the century, in the United States alone to a sum of 60 billion dollars. However, according to data from the U.S. Department of Commerce, in 1992 the amount did not exceed 5 billion dollars.

Why?

According to different estimates, modern cosmonautics is financed 80- 90% from the government budgets of foreign countries. And the principal reason for its commercialization is a changeover, at least in some fields (communication, remote sensing of the Earth, transport services), to a basis of entrepreneurship unrelated to the government budget. This makes it possible, in particular, by drawing upon the financial resources of private companies, to reduce the load on the government budget while retaining the very possibility of continuing those projects which the leaders of the country regard as important from the point of view of governmental interests, but does not have the necessary resources for seeing them through.

However, the development of commercial space activity does not immediately result in an appreciable savings in government expenditures on cosmonautics. As indicated by foreign experience, here the principle "in order to obtain a profit it is first necessary to spend money" is completely applicable. At NASA, for example, since the mid-1980's a special administration for space programs has been functioning, financed from the agency budget. The sums which this administration has are expended for the most part on maintaining the activity of so-called commercialization centers organized by the administration itself, and also by universities and private companies. The fraction of the financing of these centers on the part of NASA is gradually being decreased with an increase in the fraction of contributions of NASA partners, which also was one of the principal goals in establishing the mentioned centers.

How Does All This Relate to Us?

Since market relations are only beginning to take shape in the Russian economy, we still have no sellers of space services independent of financing from the state budget nor buyers capable of paying for them. Accordingly, the process of commercialization of cosmonautics implies the appearance of both and obviously must transpire within the framework of a general policy of reformation of the national economy.

It seems no less evident that the goal of commercialization of some aspects of cosmonautics cannot be separated from other aspects of Russian space activity. For example, such as ensuring national safety, socioeconomic progress of the country and broadening knowledge concerning the environment. But the solution of most of these problems will be ensured at least in the foreseeable future by state aerospace companies. Accordingly, it is possible to speak of commercial space activity of those aerospace companies which arose on the path of finding partial or complete independence. Here it is necessary to add universities, academic institutions, as well as television and radio broadcasting and communication companies, pharmacological, insurance and advertising companies, not dependent to different degrees on state financing.

In this connection the question arises of the choice of a strategy for a state policy with respect to commercialization of Russian cosmonautics. It is obviously necessary to direct funds to the creation of an internal market for space services and to ensure a dominant position of national companies in it. It also is impossible to preclude the need for introducing protectionist measures for its protection against expansion on the part of foreign competitors. In the United States, for example, the launching of government satellites, accounting for about 80% of all the payloads originating in that country, is accomplished only by American transport companies.

The development of the internal space services market is something new for our cosmonautics. Here it is scarcely possible to count on fast results. However, precisely this activity must be taken into account when using the term "commercialization" of Russian cosmonautics.

Efforts of NPO Applied Mechanics To Enter Commercial Communications Satellite Market

937Q0014 Moscow ROSSIYSKAYA GAZETA in Russian 19 Oct 93 p 3

[Article by Yuriy Vakhrin, special correspondent, Krasnoyarsk: "Space, Open for Business"; first paragraph is source introduction]

[Text] **They set the plant up on the banks of the Yenisey in 1959. In 1964, the Scientific Production Association [NPO] of Applied Mechanics put out its first product—the Molniya communications satellite. Recently, that enterprise, which was based at the closed Krasnoyarsk-26, was declassified. One of the many articles that appeared about that, as I recall, was topped with the sensationalist headline "They Make Spy Satellites Here." About the "spy profile" I can't really say, but this is the place where they produce all the communications satellites—they develop them here and engineer them.**

That simplicity and unassumingness is the source of many of the problems that have always accompanied the difficult life of the behind-the-scenes, working space-sector. The first such problem is the principle of left-over financing.

"Manned space was the first priority," says Academician Mikhail Reshetnev, the general designer of NPO Applied Mechanics. "Then came Energiya and Buran. And only then did anything make it to us. When we were making the first Gorizont, for example, everybody was running around here all nervous. And why was that? The television signal from the 1980 Olympics had to go abroad. The vehicle for one trunk ('trunk' is the professional slang for satellite relay) had gone up successfully. But at the time, we were already developing a complex vehicle Potok SV for 30 trunks. But they didn't give us any money for that."

The current state of the economy in this country is altogether critical for the builders of space vehicles. The Ministry of Communications, for example, ordered three Gorizonts not too long ago. That's fewer than usual, but it's something. However, only recently did the ministry itself receive the money from the federal budget and transfer it...to the Ministry of Defense, which really has a lot of debts. "That's where our millions just disappear," explained the Krasnoyarsk people.

But if the Ministry of Communications doesn't receive the Gorizonts, neither do we, the TV viewers and radio listeners. "Hovering" at 10 specifically calculated points in geostationary orbit today are Gorizonts that transmit TV signals. Half of those vehicles are already past their guaranteed service life, and the rest are nearing the limit of that service life.

"You have a one-year guarantee on a television," says Gennadiy Butych, lead designer at NPO Applied Mechanics. "For our Gorizonts, we give a five-year guarantee. You can't bring them into the repair shop if they break. Which means we have to replace them on a regular basis."

The conversation with Gennadiy Vasilyevich [Butych] is taking place on the upper platform of the jig where work is under way on the new space complex Gals.

"Not too long ago, some important guy from Moscow came to us," Butych says. "We showed him this satellite, and told him that we built it for Russia, but that Russia isn't going to get it. Then we said that it's already been sold to the Americans." He said, "How can that be? Does the President know? Has it been reported to the Council of Ministers?" Yes, we said, everybody knows about it. But nobody's being sensible about it.

But the builders of space vehicles aren't ready to perish under the debris of the collapse. They intend to swim out on the market's waves and reefs.

The workers have formed a joint-stock company. The joint-stock company has been around for about a year, so it's still too early to talk about any big results. But here are the first results: this year, the joint-stock company is providing 32 percent of the financing for the enterprise, and it has found orders, as well as customers that are not among the enterprise's traditional customers.

"We haven't invented anything," says Fedor Klimov, deputy general director for economics of NPO Applied Mechanics. "We're going the route of collaboration between state and private capital, and we're attracting private investors, including foreign investors, plus money from interested agencies and companies in Russia and the other countries of the CIS. We plan to build our own plant and set up the joint manufacture of units and assemblies with the state enterprise. We expect to reorganize existing space communications and replace the state system with a commercial system. Of course, that's not something that the relatively small joint-stock company Prikladnaya Mekhanika [Applied Mechanics] can do by itself. That job is being shouldered by another joint-stock company, Informkosmos, which, in addition to the Krasnoyarsk people, has brought together a number of commercial and state structures—specifically, the head enterprise for communication systems of the Ministry of Communications of Russia—plus developers, relayers, communications people, users, bankers, etc. That represents a chain: designers-producers-users of space communications equipment, plus those who do the marketing in this particular sector of the market, to include the world market. On the world market, of course, people weren't anxiously awaiting Russian commercial space, and they're not welcoming it with open arms. So today we've been forced to look for niches there that nobody has filled yet."

"We're working for the future," continues Klimov. "To the 32 percent of our Applied Mechanics joint-stock company, the assets of Informkosmos have been added—that's an additional 30 percent of the fiscal revenues of the NPO in all—and more than half of the needs of the enterprise have been covered. We're not just financing a specific item or a specific order for some such satellite. We're also dealing with scientific and design advances associated with totally new space vehicles."

The stockholders acknowledge that it's difficult to sell a promise or a pledge on the market. But they're selling them, receiving prepayment for Intersputnik from, for example, American companies, and finding still other clients.

Mikhail Fedorovich Reshetnev showed me the "Program for the Development of a System of Communications Satellites Leading Up to the Year 2005."

"Of the 16 billion rubles [R] needed to implement the program, only R1.5 billion (in 1991 prices) is expected to be sent from the budget—less than 10 percent. All the rest is assets of communications services users. Nonstate structures such as Informkosmos, Merkuriy [Mercury],

Marafon [Marathon], and the joint-stock company Applied Mechanics. And that's feasible."

After illustrating the potential of commercial space in that way, Reshetnev immediately turned the situation around:

"So our critics have to have the last word on everything: it's the budget, or it's the assets from the users. Either the taxpayers pay for everything, or those who make use of the space communications. Either or."

In fact, articles have recently appeared in the press regarding "our selling-off of our space-sector properties, our secrets, our radio communication frequencies," and so forth. Here's Gennadiy Butych's reply to that:

"When I hear someone say that 'Russia is being sold off,' it annoys me. When we sell timber or oil, it's not really ours—we didn't make it. Our 'product' is our labor—we haven't stolen anything from our offspring, and we have every right to sell it."

By the way, in the United States, 12 percent of the national space program is financed by private sources; over here, we don't even have a half of a percent yet from private sources.

I met with the person who is directly responsible for "selling off" Russia.

"Unfortunately, it's not going very well," laughs Petr Sivirin, the executive director of the commercial company Mercury, Ltd., which used to be based in that same Krasnoyarsk-26. "We have the same kinds of problems: we have clients, but they're tight with their money. Our company was created to use existing space systems on a secondary basis. To put it simpler, the capabilities of the satellites that are aloft are not being utilized fully: as the communications people say, they're 'idling.'"

The Luch, for example—not even five percent of which was being used before—is loaded today to almost 50 percent of its capacity. That's still pretty low, though.

It might make sense to mention here the expanding collaboration between Russian commercial structures and foreign firms—American, Canadian, and French firms.

"There are customers for our products in virtually every country of the world," says Mikhail Reshetnev. "We get telegrams from China, Pakistan, Malaysia, Thailand, Turkey. If we realistically assess the economic situation the enterprise is in, we don't have any business ignoring those orders. We should take them, but we don't."

Why not? Well, here's where there's a contradiction between, on the one hand, the commercial enterprise that is the joint-stock company Applied Mechanics and, on the other, the state enterprise that is NPO Applied Mechanics. Plant space is "chartered," as it were, for state orders, for satellites that Grachev's department has ordered from the NPO. But the department doesn't have any money, or anything to do with those satellites. The plant space is "without work."

"As difficult as it has been," says the general designer, "we've arrived on the market, and we don't intend to leave. Our eyes are open, and we understand that the principal advantage we have to offer today is inexpensive products and the fact that we're selling our labor and intellectual potential cheap. It's a pity, of course. But things aren't going to be that way forever."

Plans for Proton Launch Facility in Papua New Guinea

947Q0010A Moscow SEGODNYA in Russian 7 Oct 93 p 8

[Article by Mikhail Chernov: "Into Space in the Tracks of Maklay. Russian Commercial Launchings From the Territory of New Guinea"]

[Text] The first Russian rocket personnel, specialists in the designing and construction of launch facilities, will soon be sent to New Guinea. Russian Proton boosters will launch satellites on a commercial basis from these pads. In New Guinea there is a so-called Maklay Coast. The famed Russian traveller and explorer last visited there in 1883. A hundred years after this event the Australian Space Transportation Systems (STS) company signed an agreement with several Russian enterprises, within whose framework the world's first private spaceport, the Pacific Space Centre, will be constructed on one of the islands constituting part of Papua New Guinea. The Russian side will take care of the designing and construction of the launch facilities and also will deliver three-stage Proton boosters. If required, they will be supplemented by fourth stages—the propulsion units necessary, in particular, for the launching of communication satellites into geostationary orbit. From Baykonur the Proton lifts communication vehicles weighing up to 2.4 tons into geostationary orbit. In the case of launching from the Pacific Space Centre, due to its closeness to the equator, the payload for a standard rocket can be increased to four or more tons. Such well-known enterprises as the State Scientific Production Space Center imeni Khrunichev (Protons), the NPO Energiya (propulsion unit), the General Machine Building Design Bureau (launch facilities) and some other organizations are participating in implementation of the agreement jon the Russian side. The Australian STS company is taking on itself all concerns related to the attraction of clients and the organization of commercial launchings. It must be said that the idea of establishing such a spaceport was already conceived long ago. The USSR Glavkosmos at one time was actively working on it. Initially it was proposed that a commercial spaceport be constructed on Cape York in Australia. Zenit rockets would have been launched there. The need for launchings of communication satellites was great and remains great. A sort of "triumvirate" was set up: Soviet organizations, Australian and American companies. There was conformity to all the juridical conditions necessary for implementing this project. If everything had gone normally, already

this year the first Zenits would have risen into orbit from Cape York. However, due to American opposition the matter was brought to a standstill. Later many changes also occurred in Russia. But the idea did not die. The STS company, most likely, thoroughly investigated those hidden impediments on which its predecessors had collided and found a way to overcome them. A significant error crept into the communications of some information agencies, notes Vyacheslav Dukov, deputy director of Glavkosmos: it is stated that the agreement provides for the transfer of Russian rocket technologies to the Australian side. The facts are completely the opposite. The sides reached an agreement that the construction of the spaceport is in full correspondence with COCOM rules and regulations on the nonproliferation of rocket technologies. It also is emphasized that the agreement does not provide for the transfer to the STS company any technologies relating to the Proton and the propulsion stage. The spaceport, it is noted in the agreement, is setting up a security system for preventing the leakage of technologies with respect to both the booster and payload. With respect to the Russian side, the agreement was checked for "legal and juridical purity" at all governmental levels, including the office of the prime minister, Ministry of Foreign Affairs departments, Ministries of Defense and Foreign Economic Relations and other organizations. It also can be noted that the project to some degree quieted recent antagonists—the Russian Space Agency and Glavkosmos. At any rate, here they are in common agreement. The authorities in Papua New Guinea are favorably inclined to the project, feeling that a spaceport, not violating the corresponding jinternational juridical norms, is capable of advancing social development. The launch trajectories, assert the Russian specialists, will be selected in such a way that they will not constitute any threat for the population. There will be conformity to all ecological requirements. Russian launch equipment, as is well known, is characterized by a high level of automation. The technical personnel who are to execute launchings will undergo training in Russia. The launch teams will include representatives of different countries. In October of this year a Russian-Australian team of specialists will carefully explore the northern regions of Papua New Guinea in order to settle on a place for constructing the spaceport. The cost of this project is estimated at approximately 900 million dollars. The beginning of commercial launches is planned for 1998.

Russia's Prospects in Aerospace Plane Development Assessed

947Q0017A Moscow KOMMERSANT DAILY in Russian No 204, 23 Oct 93 p 8

[Article based on materials supplied by contributors Sergey Morgachev and Sergey Rumyantsev: "Russia Has Joined the Struggle for a European 'Shuttle'"; the first four paragraphs provide general information about aerospace planes and the fifth paragraph is an introduction]

[Text] Aerospace planes (ASP) is a collective term which includes multiply reusable space systems which to one degree or another during takeoff and landing make use of the possibilities of aerodynamics. Multiply reusable systems with a vertical takeoff put into orbit in a "rocket" mode and then making an aerodynamic ("aircraft") landing can be regarded as the first generation of such technology. These include the already existing Space Shuttle and Buran, as well as a number of planned systems (see table). The next generation of projects is based on the principle of an aerodynamic takeoff from a subsonic carrier aircraft. Finally, work has begun on ASP with a horizontal airfield takeoff. They are intended for use with a hypersonic carrier (propelling craft) as a returnable first stage or for propulsion to hypersonic velocities and entry into a circumterrestrial orbit using their own engines.

Range of applicability of ASP: putting satellites into orbit and their removal from orbit, transport servicing of orbital stations, assembly of large orbital complexes and vehicles for interplanetary expeditions, technological, scientific and military programs.

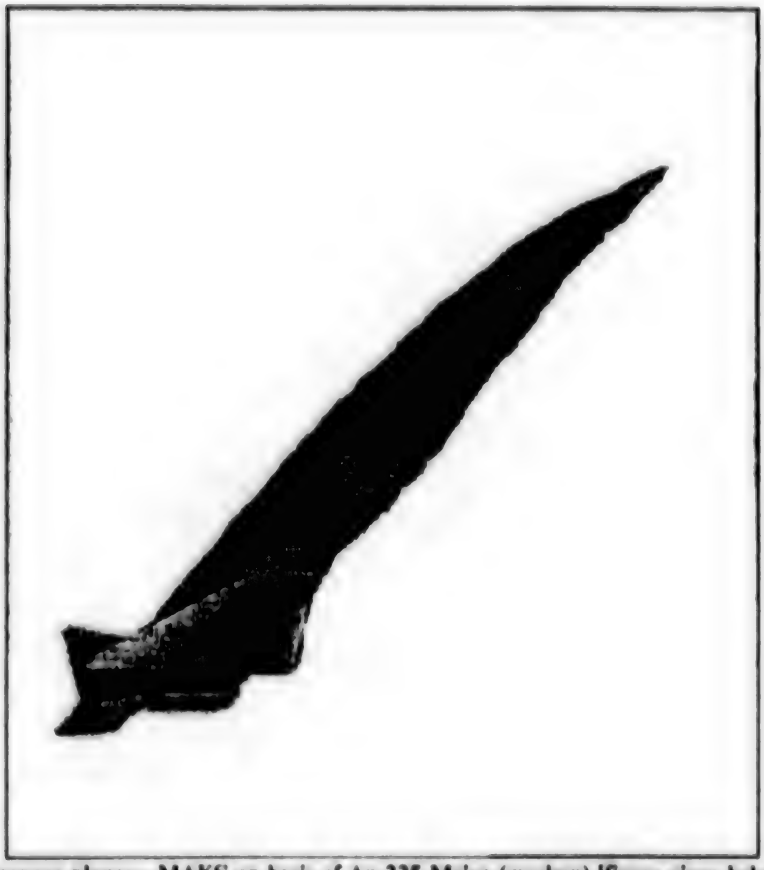
The technical progressiveness and economic efficiency of ASP are determined by their multiply reusable (returnability) character itself, but also (for future systems with aerodynamic takeoff) by a sharp increase in the fraction of vehicular payload and a considerable simplification and lessening of the cost of takeoff facilities.

Whereas for single-use systems, as well as the Buran and Shuttle systems, the cost of putting 1 kg of payload into orbit is about 12-15 thousand dollars, for projects with a horizontal takeoff from a subsonic carrier this figure may be reduced tenfold—to 1500 dollars and for ASP with an airfield takeoff, according to some estimates, it may be reduced to 500 dollars per kilogram.

Aerospace planes, whose era began with the Space Shuttle and the Buran, undoubtedly will dominate in the future world space market. Russian enterprises have done impressive technical development work in this field, but state financing of ASP programs has now ceased. Under these conditions the possibility of Russia joining in the European "shuttles" program, recently taking shape quite clearly, is acquiring decisive importance. The NPO Molniya (the main Russian enterprise working on the "shuttles") is pinning great hopes on the presentation of their project at the Berlin Aerospace Show (May 1994). During the past week the NPO Molniya received an official invitation from the organizers. The situation in the technologies market for multiply reusable space systems is examined by our reviewer Sergey Morgachev and the expert Sergey Rumyantsev.

Priority of Russian Enterprises

With respect to technologies for aerospace planes (ASP) Russia is five years ahead of the United States and ten years ahead of Europe. The leading position of Russia is indisputable, at least in the following fields: further development of the concept of a horizontal takeoff from



Russian projects of aerospace planes—MAKS on basis of An-225 Mriya (mockup) [figure given below] and Tu-2000 [above].

a subsonic carrier (NPO Molniya); further development and construction of a fundamentally new liquid-fuel rocket engine with specific thrust characteristics exceeding the best world developments by a factor of 2-2.5 and making it possible to almost double the mass of the launched payload (NPO Energomash); technologies of heat-resistant composite materials of the "carbon-carbon" type used in the load-bearing structure of the ASP (All-Union Aviation Materials Institute (VIAM), Central Aerohydrodynamics Institute (TsAGI); research on hypersonic aerodynamics and development of hypersonic ramjet engines (TsAGI, MKB (design bureau) Raduga, Central Aviation Engine Building Institute (TsIAM).

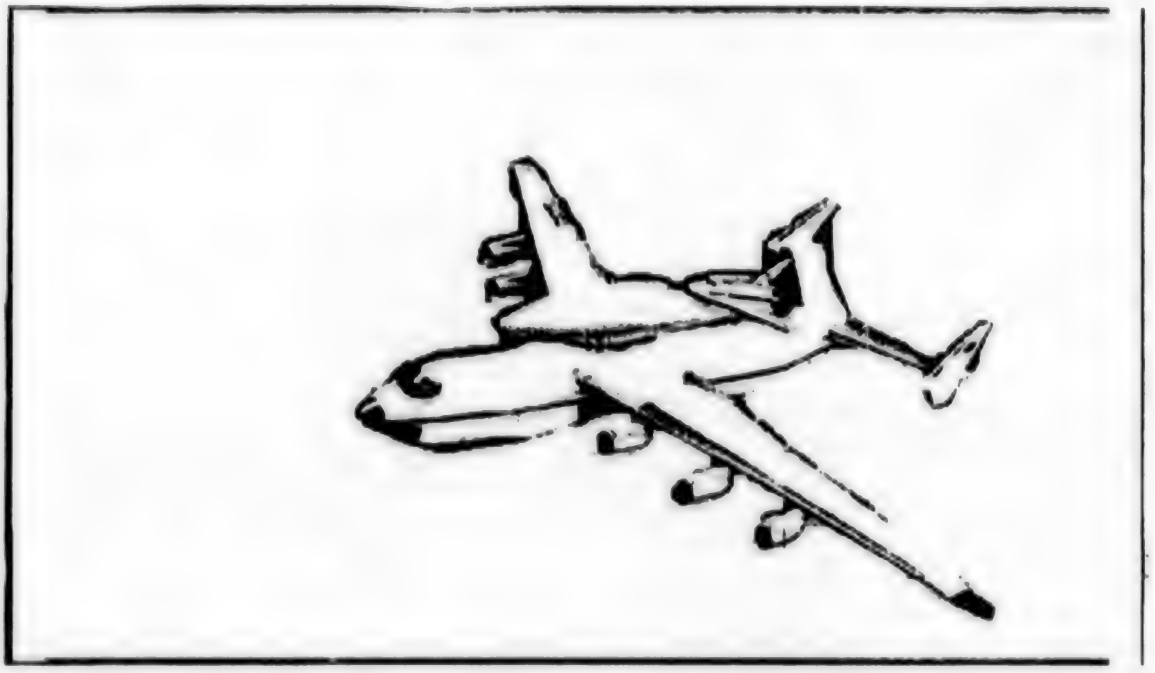
MAKS Project

Despite such an advantageous position of Russia with respect to technical competition, the allocation of new state funds for old or new ASP is not foreseen in the immediate future. Under these conditions the principal hopes of Russian enterprises are resting on attempts to "push through" a new project of the NPO Molniya, the MAKS project, putting it on the world market.

The principal idea of MAKS (multipurpose aerospace system) is the launching of an orbital aircraft from an An-225 superheavy transport aircraft, the Mriya (O. K. Antonov Special Design Bureau, Ukraine). Considerable advance work has now been done on the project: there have been flight tests of the Mriya carrier aircraft and construction has been completed on a second copy; work has been completed on design documentation for the ASP; much advance design work has been done on the aircraft power plant; a full-size mockup of an external fuel tank has been constructed and a full-size mockup of the ASP is being completed.

The project (including experimental production and flight tests of two carrier aircraft, three orbital aircraft) can be completed in 5-6 years with financing of about 200-300 million dollars. This more than modest sum for programs of this type very easily could be handled by Russian commercial investors. As our correspondent was informed at the NPO Molniya, the Moscow commercial joint-stock entity Aviabank proposes the setting up of a joint-stock company for constructing the MAKS and has agreed to become one of the investors, but this idea is far from realization.

Meanwhile, in the European market of orders for work on ASP a situation has taken shape under which with due activity of the NPO Molniya and support at the governmental level there may be a redirecting of a great part of



these orders to the MAKS project. In actuality, the financing of the only MAKS competitor, the Interim-HOTOL project, providing for the launch of a British orbital aircraft from this same An-225 (Russian enterprises also were included in work on this project), has now been stopped. (The HERMES as a representative of a class of lighter ASP does not compete with the MAKS.) This pause arose, in particular, in connection with the interest of the ESA (European Space Agency) and Great Britain in the MAKS project, which in its technical possibilities seems preferable. In January 1993 Great Britain, on its own initiative, made an official presentation of the Russian project at the regular ESA congress. It is evident that the European partners are now studying variants of use of leading Russian technologies in their own rocket-space industry.

MAKS also is of interest to American companies, one of which, as was reported to our correspondent at the enterprise, "proposed examination of the possibility of participation in financing of the project." American companies also have indicated separate interest in one of the MAKS components—a liquid-fuel rocket engine developed by the Khimki NPO Energomash. In the very near future the conclusion of a number of agreements on this engine is anticipated.

Potential World Market for Launches of ASP and Appropriations for Their Development

Key: 1. Appropriations of national and international organizations for scientific research and experimental design work. 2. Profits from launches. 3. Billion

Existing and Promising ASP

Project	Country	Main enterprise	Takeoff method	Mass of lifted load, tons	Crew, persons	Year of first flight	Stage of project
Space Shuttle	United States	Rockwell, Rocketdyne	Vertical	27.2	2+5	1981	4 vehicles constructed
Buran	USSR	NPO Molniya	Vertical	30	?	1988	2
HERMES	ESA	Dassault-Breget	Vertical	3	3	1999	Work planning
HOPE	Japan	Fuji, Mitsubishi, Kawasaki	Vertical	3	0	1999	Work planning
MAKS	Russia	NPO Molniya	Subsonic carrier aircraft	8.3	2	1997	Work planning
Interim HOTOL	Great Britain/ Russia	British Aerospace	Subsonic carrier aircraft	7	3	1999	Draft planning
ZENGER	Germany	MBB	Hypersonic propulsion craft	3	5	After 2005	Conceptual development work
STAR-H	France	Dassault-Breget	Hypersonic propulsion craft + single-use rocket unit	3	3	After 2005	Conceptual development work
NASP X-30	United States	North American Aviation, General Dynamics, McDonnel Douglas	Single-stage hypersonic craft	no data	2	After 2010	Conceptual development work
Tu-2000	Russia	ANTK imeni A. N. Tupolev	Single-stage hypersonic vehicle	no data	2	After 2010	Conceptual development work

Tu-2000 Project

Work on the Tu-2000 single-stage hypersonic ASP, with launching from an airfield, carried out by the ANTK imeni Tupolev in collaboration with the Central Aero-hydrodynamics Institute, is promising for the more remote future. A great volume of aerodynamic strength and thermal tests has been carried out on a project for an experimental small hypersonic vehicle, whose first takeoff, with continuing financing of the work, may be in 2004. One of the possible forms of realization of this work also may be the development of a hypersonic passenger liner. State financial support for this project is virtually frozen and it also requires investments.

Outlines of Future Market

By the time of the anticipated arrival of new ASP on the commercial launches market (2000-2005) there will exist a considerable excess of demand over what is offered (in actuality, it exists even now). It is assumed that more economically efficient ASP, having great technical possibilities, will not only fill this unoccupied market niche, but also to an ever greater degree will squeeze out single-time use systems from the remaining part of the market. In the very first approximation it can be assumed that of the 50 commercial launches which will be carried out annually beyond the boundaries of Russia by the year 2005 ASP will be able to put in a claim for half (expressed in costs this may be about 1500 million dollars). The market for commercial ASP launches in Russia by that time may attain about 10 launches per year (the "internal" prices for a MAKS launching in Russia will be an order of magnitude lower than world prices, which could be about 60 million dollars). It also must be remembered that there is a market for launches by orders from government, including military, agencies—it is now about ½ the world market.

The splitting up of the future market for multiply reusable space systems is beginning even now in the form of a struggle for budget appropriations and credits allocated for ASP projects. Naturally, the course of this struggle is determined to a great degree by considerations of a protectionist character, but the technical achievements already made by Russian enterprises constitute a good trump card which it is necessary to know how to play.

Telephones: NPO Molniya—(095) 497-47-60, NPO Energomash—(095) 572- 76-49, ANTK imeni A. N. Tupolev—(095) 263-79-01.

Russian Parachute Institute To Work on Ariane-5 Recovery System

947Q0021A Moscow SEGODNYA in Russian 28 Oct 93 p 8

[Article by Mikhail Chernyshov: "Russian Parachute Makers Under Spanish-Dutch 'Roof'"]

[Text] Specialists in our country have undertaken the designing of a recovery system for the West European Ariane-5 booster. This seemingly isolated fact is being vigorously discussed in the West European and American press. But there are reasons for that.

Until now boosters have been used a single time. A booster lifts a payload into orbit and the life of the booster—a highly complex technical object—is at an end. The stages of a booster, rising into the sky, having performed their mission, fall downward. If they could be lowered "softly," by parachute, after being refueled they could again be sent to the launch facility and the costs would thereby be reduced by many times. Designers have worked hard on this problem for decades, but for the time being there is no satisfactory solution.

"To achieve multiple reusability of a booster is the same as wanting this from a well-known contraceptive," somehow noted one highly placed space official in an offhand comment.

But nevertheless the European Space Agency (ESA), creating the Ariane-5, a new-generation booster, is ready for "partial reusability": lowering by parachute not the entire booster, but only the so-called propulsion units. Even in this variant there can be a substantial decrease in transport costs when putting payloads into orbit.

As is done in Western practice, in such cases a competition was announced for the companies which could propose an optimum variant of solution of this problem. American and West European aerospace corporations participated in it. The winners turned out to be Simsa in Spain and Fokker in the Netherlands. But in actuality behind them stands, and this is no secret to anyone, the Scientific Research Institute for Parachute Making.

Russia could not participate directly in the ESA competition. This was a privilege for its members only. A roundabout variant was selected, through intermediaries. And that did the trick. Because, strictly speaking, the Scientific Research Institute for Parachute Making had no competitors having practical experience in the mentioned field.

It is assumed that the idea of a parachute originated with Leonardo da Vinci. But only late in the 18th century did the Frenchman Andre Jacques Garnerin in Monceau Park, not far from Paris, brilliantly demonstrate his brainchild, making a jump from a balloon. For almost a century parachuting enthusiasts followed in Garnerin's footsteps. In Russia the numerous family of the Drevnitskiy brothers, participants in the "Aerostat Performances," gained enormous reknown.

Parachutes for a long time now have not been simply cut from silk and sewn, but are really constructed, like any technically complex object. The synthetic fabric Kevlar is used for canopies instead of silk. Its fibers are ten times more resistant to breaking than are steel filaments. There are devices ensuring an exceedingly dense packing of the canopy. In most cases it is not a single "canopy" which is used, but a system of canopies. Accordingly, there also are programmed mechanisms which control a series of operations for deploying the parachute.

Moreover, the operation of recovery systems under extremal conditions indicated that the behavior of a parachute in different phases—deployment of the canopy, its filling with air or, shall we say, with carbon dioxide, as on Venus, soaring—all this requires careful computer simulation. Such methods, in combination with experimental data obtained using aero- and gas-dynamic stands, as well as in real- scale tests, in essence also constitute the basic intellectual capital for any parachute making enterprise. At the Russian Scientific Research Institute for Parachute Making it was greater than at others and hence the actual victory in the competition.

All the work on developing the system for the Ariane, according to Leonid Molchanov, an institute specialist, will take approximately two years. The scientific research institute is designing, testing and fabricating only two parachute systems for the ESA; the know-how remains our property. The ESA will check performance of the parachutes during the first two experimental Ariane-5 launches. The matter of extending work under the contract will be decided upon depending on the results of these tests.

However, the problem of multiple reusability is not solely limited to a soft return of a booster unit to the surface. It is necessary that the object be found and transported to the manufacturing plant or to a special workshop at the cosmodrome where the condition of the unit will be carefully checked and individual systems replaced. Only thereafter can it be refueled. All this fuss and bother, incidentally, gives rise to a skeptical attitude toward the idea of multiply reusable boosters among many specialists in Russia, the United States and France.

In the last analysis we are talking about only two parachutes. But the Western press is writing about a Russian breakthrough in the high technologies field. And as proof of this, new contracts have been offered from abroad: the Scientific Research Institute for Parachute Making is busy with their examination.

NPO Lavochkin Discussing Lunar Mission With NASA

947Q0026A Moscow SEGODNYA in Russian 4 Nov 93 p 8

[Article by Mikhail Chernyshov: "'Lavochkin' To Fly to the Moon? The United States Is More Interested in It"]

[Text] The Russian aerospace enterprise Lavochkin is conducting negotiations with NASA on participation in work under the lunar program. Foreign mass information sources already have reported that Lavochkin supposedly is fabricating some lunar module for NASA. In actuality, however, for the time being a search is being made for directions and possibilities in which cooperation is possible.

A sort of pendulum process is traced in Russian-American pretensions for mastery of the moon and Mars.

A space race of unprecedented scale for primacy in landing a man on the moon developed between the Soviet Union and the United States in the 1960's-1970's. During those years, incidentally, the greatest expenditures on space were made by both countries. In the United States they attained almost 4% of the federal budget. Today this item has been reduced fourfold. The total NASA budget, in which the planetary theme occupies an extremely modest place, is a little over 14 billion dollars per year.

The Soviet Union not only carefully concealed its work on preparation for manned lunar expeditions, but also ingeniously "spread out" expenditures on them under other budget items. We still do not know and it is unlikely that we ever will know how much the space ambitions of the leaders of the country have cost the Soviet taxpayer. Only such "indirect evidence" as the enormous structures at the Baykonur cosmodrome make it possible to conclude that the real expenditures of human and material resources in the USSR were comparable to the expenditures by the Americans. According to some estimates, not less than a million people worked in the Soviet rocket-space industry at the peak of "lunar activity."

Losing the race to the Americans, the USSR declined to carry through with its lunar manned program. In 1976 the Luna 24 automatic station returned the last consignment of ground to the Earth. That put an end to the lunar program. But as soon as interest in the moon fell off sharply in both countries, discussions began about a possible assault on Mars.

As in the case of the moon, both countries in their time have sent a number of automatic stations for studying the "red planet." These missions did not always end successfully. The Soviet Fobos stations experienced failure in the final stage of the flight. They were intended for investigating one of the natural satellites of Mars. Communication with the American Observer probe was cut off. The Mars-94 project encountered financial problems.

Only several months ago Vyacheslav Kovtunenko, general designer of the NPO Lavochkin, stated that as a result of inadequate financing of the work—only a third of the necessary amount—the enterprise is losing subcontractors. The project, in which, incidentally, over ten participants from different countries are involved, is threatened with a cutoff. Almost for sure the implementation of the Mars-94 program will be postponed to 1996. A departmental commission is now functioning which is trying to analyze all the unsolved problems, but this task is scarcely going well.

But meanwhile in the United States a return of interest in lunar research is being observed. In research laboratories not only in the United States and Russia, but also in many other countries, work related to study of methods for processing of exoplanetary minerals and their delivery to the Earth is being carried out.

With respect to the natural wealth of the moon, more than a few legends took form during the years of the space era. It was even asserted that the moon was something like an Eldorado where each cubic meter of ground contains gold, platinum, rare earths and fuel for thermonuclear reactors. Alas, the truth is more prosaic. Exploration of the moon by American and Soviet probes, as well as expeditions of American astronauts, indicated that the moon differs little from our own planet. However, for the time being nothing is known about the layers lying beneath the lunar surface. So that if earthlings again set foot on the moon it will not be as exploiters, but only as researchers.

Why does NASA need to cooperate with the Lavochkin enterprise? The enterprise, designing remarkable subsonic and supersonic aircraft, later changed its direction. The Luna and lunokhods, Mars, Venera, Vega and Fobos all were Lavochkin products.

The future will show whether or not the Lavochkin enterprise will find its place in the sun. But for the time being the moon remains "afloat."

Capabilities of Space Sector, Need for Government Support Viewed

947Q0022A Moscow ROSSIYSKAYA GAZETA in Russian 9 Nov 93 First Edition p 3

[Article by Mikhail Rebrov: "Yes, We Make Rockets! Russian Space Complex Capable of Putting Country Into New Orbit"]

[Text] The paradoxes of our time no longer cause surprise, but instead give rise to sadness. Only yesterday the cries "we are ahead of the entire planet" sounded with bravado, but today to an incredible degree we eat humble pie. To be sure, however, in this tale there is a more than a little irony. But there also is truth in it. Our attainments in the cosmonautics field delighted the world and caused envy. And also respect. The Mir multimodule orbital scientific complex operating over the planet even now has no equals; the Americans only intend to create something similar. I note: with our assistance.

But today cosmonautics in our country is in ill repute. People speak and write about this with unconcealed vexation, calling the expenditures on space research both "excessive" and "thoughtless" and "useless." "What long-awaited gifts have we received from space? Manna from heaven? Escape from disease? Improvement in life on our sinful planet? Oh, if these billions had only been expended for the benefit of the common man: on housing, on medicines, on pensions and wages." Hence at meetings appeals have been heard: close, downsize, redistribute.

But let's not be bitter; let's strive to be objective. Perhaps have attainments in the space technology field not been transformed into the reality of global radio and TV communication? Perhaps have meteorological satellites not made weather predictions more precise and long-range? Perhaps it would have been possible to solve highly complex navigational problems without specialized space vehicles? And mapping, geological prospecting and environmental protection—all these became more routine and economically advantageous when instruments for observation of the entire planet appeared in the arsenal of science and the most different economic branches.

Not wishing to take second place to us in space activity, America spared no cost in asserting for itself the status of a leading space power. The Apollo lunar program, the construction of the Skylab orbital station and the multiply reusable Shuttle cost many tens of billions of dollars. There was but one objective—first to overtake Russia and then to break ahead. And that was accomplished.

However, it must not be thought that only prestige considerations forced the energetic and pragmatic Americans to join the "space race." They know how to count and invest great sums only in those projects which promise great profits. While spending 24 billion dollars on the Apollo program, American industry earned about 300 billion on space patents!

The practical Americans calculated that for each dollar invested in astronautics it was possible to receive five dollars in return. To be sure, this was not easy: it was necessary to hustle, to think, to apply all know-how efficiently. American experts assume that already in the near future the volume of sales in the space technology market will attain 10-15 billion dollars. So the "second space power" is striving to occupy its solid niche there, and a little bit more.

And what about us? What are we doing? What are our hopes? Somehow I chanced to read the following: the well-known and legendary space enterprise where the Vostoks, Voskhods and Soyuzes were constructed, the Energiya-Buran aerospace complex, is intending to acquire new fame in the production of consumer's goods. In principle this is all well and good. We certainly need sauce pans and frying pans and kitchen equipment (even if outmoded, but under licensing from Sanyo in Japan). However, there are male cowards who poke fun at the former "mailboxes," as well as serving tables and even refrigerators, made by others...

So today is the term "conversion" understood and so is the term "market relations" understood. While uttering fashionable, but somehow also correct slogans, like "Forward—to the market!" we somehow are not giving much thought on how to approach such an alluring market, especially the international market. With household refrigerators? With indestructible frying pans? Who will buy them from us? And if a buyer is found in the so-called developing countries, how much will be paid and with what?

Is it possible that we still have not recognized the obvious: that it is precisely the Russian space industry which is capable of keeping the country at a worthy level,

of establishing a basis for a powerful technological breakthrough, without which an improvement in the well-being of the entire country and each of us is unthinkable?

I recall a conversation with Professor Yuriy Grigoryev, doctor of technical sciences, closely associated with the space industry for many years. "In our space systems," he stated, "there are no parts and materials brought from distant countries and there also are no technologies purchased for hard currency. This applies to the Mir complex, its modules, the Soyuz and Progress ships, our space boosters, automatic interplanetary laboratories and satellites used for practical purposes..."

And the Topaz space power plant and cryogenic rocket engines and unique methods for research and training of crews for long-term expeditions? Finally, that highly unique test base which the Central Scientific Research Institute for Machine Building, NPO Kompozit and NPO Tekhnomash have... Right there it is possible to "make" money. And more. Is it not time for us to back off from our self-flagellation and look around at what has been attained by the great talent and enthusiasm of tens of thousands of scientists, designers, engineers and workers with the highest skills and attempt intelligent application of these attainments?

Space technologies constitute an enormous wealth for our country. And we will not be naive: if we lag behind no foreign country will come to our aid. Competition is competition. When a competitor weakens he loses face and no one helps him to become an equal. Hence the sorrowful and alarming reality: they are not letting us into the international space market. Examples of this are the sensational story with the Russian- Indian contract and the "intrigues" with the Topaz and the detrimental, in my opinion, agreement on joint flight aboard the Mir and Shuttle (we will be on the American ship for a week and they will be on ours for a month)...

I foresee objections: and what about the program for space cooperation between Russia and the United States? According to Daniel Goldin, NASA administrator, the United States Senate has allocated 100 million dollars for interim use of our Mir station for flights of American astronauts. According to a statement of Yuriy Koptev, general director of the Russian Space Agency (RSA), joint projects will make it possible to put into orbit satellites and other payloads using Russian Proton boosters and American Space Shuttles.

All this is attractive. But the ink of the signatures on the document had not yet dried when changes began. NASA is proposing that the launch of the Mars Observer satellite using the Proton booster be postponed from October 1994 to 1996. Or a situation like this. As reported in the journal Aviation Week and Space Technology, at the Californian enterprise Loral Aerospace there is now an unusual lineup of 20 satellites—telecommunication and meteorological—which must be put into orbit. The company has concluded with us a commercial contract for one Proton (it is proposed that the launch take place in the last quarter of 1995) and apparently the agreement provides for the use of four other Protons during the period between 1996 and 1998. The question arises: why so few if even today there are 20 satellites lined up and the contract is for a five-year period? It also is unclear what fraction of the 100 million mentioned by Mister Goldin will be received by us. There also are more than a few other ambiguities in the commercial activity of the RSA. And the clumsiness and tactlessness of the newly made space peddlers at times is simply shocking.

Recently the weekly TIME reported that on 11 December the Sotheby's Company in New York is holding its regular auction. And what do you think will go under the hammer there? "Unique objects of the beginning of the space era in the Soviet Union," and in clarification of this TIME mentions: "the Voskhod descent module, the Eva space-suit in which Leonov emerged into open space and 200 other items of memorabilia." Is it of interest as to who is selling off our national property? By what right? With whose permission?

However, let's return to know-how. The development of the Energiya-Buran rocket-space system alone gave rise to such an avalanche of discoveries, inventions and improvements that the author's certificates issued for them could paper over an entire gigantic system. A special album was prepared which included 600 original scientific-technical advances. These included new technologies and materials, machine tools and devices, programs and methods, experimental apparatus and measuring instruments, automated control systems and coverings. And what came of all this, you ask? Almost nothing. As they say, it disappeared into the sand and remained unused.

Is there an escape from the labyrinth in which our cosmonautics has already wandered for more than a year? I make so bold as to say; "There is." The space industry was created by the state, which controlled it and financed it. Whether these investments were too generous or not very great is a subject for a separate discussion. It is important to understand that the space design bureaus, scientific research institutes and production facilities established by the state cannot survive without government orders and cannot be reoutfitted solely through their own efforts. And is it necessary that a branch using the most advanced attainments be reoriented on a lower-level technology?

I have been at many space enterprises, met with and talked with directors and general designers, I have seen laboratories, assembly shops and test stands and I know many people working at these enterprises and therefore I can state very authoritatively: they are capable independently, by their own resources, of fabricating a working model of virtually anything you might desire, of performing any kind of work from an idea to a sample of any complexity. But then it is necessary to seek out those who are ready to take it over for standard production. In short, all these scientific production associations are good as "factories"

of leading thought, continuously producing new ideas, technologies and production samples.

When appropriations for the space branch are sharply reduced, when such centers as the Scientific Research Institute for Machine Building, NPO Energiya and Khrunichev Plant are unable to supply enough work for their stands and the golden national property stands idle, the reliability of technology inevitably falls. Today the situation with such associations is such that the magnificent designers, scientists and technologists have neither the wages nor the necessary equipment. Due to the lack of centralized investments and concern about the experimental base, which must constantly be replaced, in the leading space branch we will inevitably tomorrow reap the very same fruits as in very many other economic branches.

And last. The money which the state allocates, even if it be modest, must first and foremost go for the advancement of space science and not for ambitious strivings for the "sovereignization" of individual enterprises and questionable "privatization." Alas, many efforts also are being spent in this direction. And as a result organizations are being formed which duplicate one another (such as the Russian Space Agency and Glavkosmos), control mechanisms are being lost, but on the other hand, new sharp-looking "offices" are appearing...

RSA, Defense Ministry Request Funding for Priority Space Facilities

947Q0024A Moscow KOMMERSANT DAILY in Russian 6 Nov 93 p 2

[Article by Nikolay Podlipskiy and Ilya Bulavinov: "The Leaders of the National Rocket Industry Have Been Determined"; the first paragraph is an introduction]

[Text] The promise to extend government support to enterprises of the Russian rocket-space industry given by Viktor Chernomyrdin during a visit to the NPO Energiya may be fulfilled in the immediate future. Yesterday a draft of a decree of the Council of Ministers entitled "Measures for State Upkeep of Russian Space Activity and Support of the National Rocket-Space Industry," worked out in the Ministry of Defense and at the Russian Space Agency, was received by the government.

During recent years the preparation of drafts of clearly expressed "branch" decrees of the government has become the most widely practiced solution for the problems faced by individual enterprises. In this sense the document prepared in the Ministry of Defense and at the Russian Space Agency does not differ from others worked out in other ministries or departments. For example, it is proposed that 120 billion rubles be allocated to the Ministry of Defense for paying off indebtedness for standard deliveries of space equipment, scientific research and experimental design work. In addition, once again there is the requirement for establishing an untaxed minimum salary of 8 (instead of 4) times the minimum pay scale. And, taking into account the great volume of scientific-technical and experimental-design work in the branch, the document includes a proposal on freeing from taxation that part of the profit directed to the financing of this work.

However, the quite high technological level of the Russian space industry forced the writers of the draft to include in the document a number of points not encountered in other drafts. In particular, reference is to the "selectivity" of the proposed assistance. The document mentions seven enterprises for whose development it is proposed that preferential credits be allocated.

[An inset in the text, captioned "Enterprises of the Russian Rocket Space Industry to Be Given Priority in Granting Credits," lists the following: GK NPTs imeni Khrunichev; Progress plant at Samara; SMO imeni Frunze; AO Permskiye motory; Voronezh Mechanical Plant; NPO Energomash; NPO Energiya.]

The choice of precisely these production facilities as priority objects is easily explained: they are all participating in the production of Russian boosters—the Russian space industry products which are most competitive on the world market.

And if this money is allocated, it may be directed first and foremost to the organization (on the basis of the leading space enterprises) of corporations capable of implementing work in the high-technology category in other branches: electronics, instrument making and high- speed rail transport. Such a variant of overcoming the existing technological gap between production facilities in the space branch and remaining enterprises is justified because under Russian conditions the commercial sale of high technologies is improbable. In addition, the Ministry of Defense is interested in making state support available to enterprises because existing space systems for early warning of a nuclear attack are in need of modernization, as are satellites for monitoring the movement of troops and space communication systems.

The preparation of proposals on the immediate support of the Russian space branch indirectly confirms the strategic line of the Russian political leadership for ensuring the technological and technical autarchy of the national space industry and its nondependence on enterprises in the CIS countries (which does not preclude the active cooperation of Russian space enterprises with Western partners). However, the situation may change if the Russian government is able to get from the leaders of the Commonwealth countries an agreement on conversion of the state debts of these countries into shares of their industrial enterprises. It is evident that the first to aspire to a change in "citizenship" will be precisely the high-technology enterprises of the rocket-space branch in the republics.

Principal centers of rocket-space industry in territory of former USSR.

Key: 1) Kaliningrad; 2) Plesetsk; 3) Dnepropetrovsk; 4) Kaliningrad; 5) Moscow; 6) Khimiki; 7) Voronezh; 8) Samara; 9) Verkhnyaya Salda; 10) Krasnoyarsk; 11) Baykonur; 12) rocket-space production facilities and administrative centers; 13) launch facilities

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Commentary

Positions of Russia in world rocket-space technology market

According to the evaluations of Western and Russian specialists, the world market for goods and services produced by the rocket-space industry is one of the most dynamically growing. At the present time it is quite difficult to evaluate its "dollar" capacity, but even according to the most modest estimates this is tens of billions of dollars up to the end of the century. However, the state of the Russian rocket-space industry makes it possible to say that its products and services may be competitive only in several sectors of this market.

Commercial launches market. The capacity of this sector is now estimated at 1.5-1.8 billion dollars. The market has a tendency to an increase by 5-10% per year, so that after ten years its capacity may double. The average price for launching a kilogram of payload is approximately 20 thousand dollars. Depending on satellite weight, orbital altitude and type of booster used the cost of a single launch varies in a wide range: from 5 to 100 million dollars. Russia has the greatest variety of boosters and can put a payload weighing from 1 to 100 tons into orbit. Almost all the boosters have a high reliability. In accordance with international agreements Russia has the right up to the end of this century to carry out eight commercial launches. In addition, the market for launches of foreign satellites using mobile launch facilities, for which the restrictions on the import of American satellites and their components into Russia do not apply, is extremely promising.

Manned flights market. At first glance, in this sector Russia has the most favorable prospects, related, in particular, to the existence of a permanently operating orbital complex and a well-functioning "surface-orbit" transport system. This enables Russia to remain a monopolist in the market of intermediate- and long-term manned flights. However, the "advanced" age of the Mir orbital station (it has been in operation since 1986) forces the crew to spend a considerable part of their time on the maintenance of its operability, in many cases at a sacrifice to the principal flight objectives. According to some data, the operation of this station will end by 1998. After this time the construction of the Freedom-Mir station jointly with the United States is proposed.

Space communication systems market. Due to the outmoded character of national communication systems

this sector is increasing most rapidly. Development work is now proceeding on at least five nationwide Russian communication systems using space satellites.

Applied scientific research market. The most competitive in this sector of the market is Russian "mothballed" photoreconnaissance satellites. Their capability of distinguishing objects on the Earth's surface as small as 3 meters makes them extremely competitive in mapping. The use of the remaining space vehicles of Russian production by Western clients, such as meteorological and remote sensing satellites, due to the backwardness of the elemental base and low reliability, is improbable. Uses of the outmoded but reliable technological satellites of the Foton series are the most promising.

Scientific research market. The financial crisis in the Russian economy resulted in a virtually total shutdown of scientific programs. In addition, the prestige of Russia was undermined to a considerable degree by the failure of the Fobos expedition. However, international cooperation is now continuing under one of the largest programs of this kind: the project for exploring Mars.

Market for sale of rocket system technologies and components. In this sector of the market Russia has a quite weighty advantage in the field of development and production of liquid-propelled rocket engines and nuclear power plants. However, rigorous adherence to all requirements of the regime for control of the proliferation of rocket technologies, in combination with the export control system established in Russia, make this market extremely limited. In addition, as a result of the cutoff of state financing of many development projects many Russian technologies are aging and losing their competitive advantages.

Reports From Baykonur Said To Belie Claims of Cosmodrome's Decline

937Q0027 Moscow LITERATURNAYA GAZETA in Russian No 45, 10 Nov 93 p 9

[Article by Oleg Moroz: "'Everything's OK at Baykonur'; Information on the Condition of the Largest Soviet Cosmodrome Is a Function of the Financial State of Affairs"; first paragraph is source introduction]

[Text] **In a desperate attempt to save itself and survive, our space program, once a thundering force in the world, is making every effort to obtain commercial contracts abroad. Despite the powerful counter-efforts of Western space monopolists, it has started to get some things lately...**

The international satellite Inmarsat is slated to be launched in December 1995, and the launch to orbit of a satellite of the American company Loral Space Systems (Intelsat B) is scheduled for 1996. Three launches are expected to go in late 1996/early 1997, delivering to orbit 21 communications satellites of another American firm, Motorola. Other near-term and long-term projects are under discussion. The payment owed us for each launch runs in the tens of millions of dollars.

In striking contrast to those inspiring plans is the endless array of recent articles, films, and television reports about the total collapse and ruin at Baykonur, the mass exit of specialists, the absolute thievery that reigns there, and other boundless criminal acts. "Nightmare at the Cosmodrome." "Facilities at Baykonur Are Rapidly Falling Into Disrepair." "The main spaceport has recently become so bad off that people are concerned about its survival." Those are just some of the things being said about it. So naturally, the question arises, How can satellites possibly be launched from that dead launch facility? Does it warrant the risk of Western client firms that are preparing to bring their expensive equipment into that oasis of disrepair and crime?

Such curiosity, it seems, has overcome other people besides me. At the request of the White House, staff members of the Moscow office of the American firm ANSER Royce Dalby and Brett Alexander paid a visit to Baykonur and acquainted themselves with the actual state of affairs there. I have their report about the trip in front of me. The Americans noted nothing like collapse. All their assessments of the technical conditions of the launch facility are in glowing terms: "The units for the Proton and the Soyuz are in excellent conditions." "No signs whatsoever of wear were found on any of the units." Only the Energiya-Buran complex is not functioning: it has been mothballed because of the halt in the financing of the program. But even it is serviced daily, and it is being kept in working condition, in the hope that better times are to come. According to the Americans, here again "everything is in excellent condition." The general conclusion of the inspectors: "All the reports about the rapidly worsening conditions at Baykonur are, from all appearances, heavily exaggerated or a total lie...ANSER is firmly convinced that the launch facility continues to function normally. Everything we saw confirms that the breakup of the USSR did not affect the capabilities of Baykonur."

Who said otherwise, and why? In a conversation with Dalby and Alexander, the deputy commander of the launch facility, Col Leonid Goryushkin, admitted that the entire situation at Baykonur had been "heavily exaggerated" with the consent of the facility's leadership. A special film describing the terrible conditions at Baykonur was shot so that the facility would receive additional monies from the government. According to Goryushkin, the film showed only the old launch pads—an old Proton launch pad, for example, that hasn't been used since 1997.

That's not good, of course, but what are you going to do—you have to live. A lie to save yourself, as they say.

As for the banditry and thievery at the launch facility, just the thought of such things is, in the opinion of the deputy commander, ludicrous. But other Baykonur staff

members did admit that there have been isolated cases of theft at outlying launch pads.

So everything's in order at the launch facility (which, by the way, is the conclusion reached by the representatives of all Western firms involved). Things are worse in Leninsk, which is where most of the maintenance personnel live. Everybody's of the same opinion there. "In Leninsk, you can see signs of decay," write Dalby and Alexander. "Many homes have broken windows and, by all appearances, are empty....Only rarely do the living quarters have hot water, foodstuffs are in short supply, there are interruptions in electrical power....Before the breakup of the Soviet Union, the city had 100,000 residents. Now only about 60,000 are left."

By the way, the hotel for foreigners in Leninsk is kept in good condition. And that, better than anything else, proves that the Soviet spirit is still alive. And it would seem that everything is, by and large, OK!

Legal Actions Against Baykonur Military Rioters

937Q0025A Moscow RABOCHAYA TRIBUNA in Russian 3 Nov 93 p 4

[Article picked up from ITAR-TASS: "Baykonur Rioters on Trial"]

[Text] The trial got under way recently for the organizers of the massive disorders that took place about a year ago in the Leninsk Military Garrison, which services the facilities at the Baykonur Cosmodrome.

An investigation revealed that more than 60 million rubles [R] worth of property was destroyed in garrison units as a result of the senseless pogroms and arsons. The instigators of the unlawful actions were 15 lower enlisted men and sergeants. Nine of them were arrested soon after the actions. The other six suspects hid, fearing retributions, an inquiry announced.

As it turns out, the organizers of the pogroms were individuals who had been tried in a court before and had served time at hard labor in penal colonies before being drafted into the army. The massive outpourings of enlisted men did not simply happen all at once, but were carefully prepared. One officer had reliable information about the preparations that were under way. But he did not inform anyone from garrison command about it. For having kept the preparations for the criminal act hidden in a premeditated manner, and that was proven by the investigation, criminal proceedings have been instituted against him, too.

Death of Space Designer V. P. Barmin Reported

937Q0025B Moscow IZVESTIYA in Russian 20 Jul 93 p 6

[Article with no byline: "Academician V. P. Barmin Dies"]

[Text] Academician Vladimir Pavlovich Barmin, the last of the famous six individuals who made up the first Council of Chief Designers of Space Hardware, has died.

Barmin supervised the creation of the legendary launch complexes of Baykonur, from which the first satellite and Yuriy Gagarin went aloft into the heavens and from which, to this day, rockets lift off.

Vladimir Pavlovich was born in 1909 and lived a long, happy, creative life. In the early part of the war [WW II], as chief designer at the Kompressor Plant, he set up series production of the famous Katyushas. After the war, he served as chief engineer at the institute Berlin, which studied the German rocket hardware. After returning to Moscow, he headed the design bureau that became a powerful organization involved in the creation of rocket launch complexes at Baykonur, Plesetsk, and military launch sites.

That design bureau created equipment for collecting and analyzing lunar and Venusian soil. A good many other projects whose objective was the exploration of the solar system were performed at that bureau. In recent years, that design bureau has devoted much attention to the development of projects involving the use of technologies in conditions of in-orbit microgravity. The solid design bureau formed under the leadership of V. P. Barmin continues the along the stellar path carved out by its founder.

Agreement on Joint U.S.-Russian Space Station Project Reported

937Q0025C Moscow TRUD in Russian 17 Nov 93 p 1

[Article with no byline under the rubric "Here's News From TRUD Correspondents and Information Agencies": "'Alpha To Launch in the 21st Century"]

[Text] Plans call for the creation of an international orbital station under the provisional name of Alpha to get under way in May 1997. At a press conference yesterday, that was reported by the director of the Russian Space Agency (RSA), Yuriy Koptev, who was heading the Russian delegation at talks that were completed last week in the United States, where the project was coordinated.

Russia and the United States will begin the work, and then they will be joined by the European Space Agency, Canada, and Japan. Alpha is expected to be ready by the year 2000. Of the $400 million allocated by the United States for performing the work in the program, the Russian Federation will receive $350-370 million, the head of the space agency noted. That figure is roughly the equivalent of four years' worth of state budget allocations for space. That will help domestic specialists who have been experiencing immense economic difficulties in recent years to "survive the next 2-4 years."

Russia is becoming a full-fledged partner in the international project, the RSA director stressed. That means that it will contribute to the project equipment and technologies on which it is spending money and intellectual resources. As a result, it will be able to conduct research on the future orbital complex. At the same time, however, Russia loses the possibility of building its own station—the Mir-2, which was to replace the Mir station, which has run the length of its service life. There simply isn't enough money for two parallel projects.

By the 21st century, a permanent crew of six will be able to man the Alpha (which, Yuriy Koptev added, may in fact be called the Sigma, "as a sign of the integration and build-up of the capabilities of the participating countries").

Koptev Press Conference Stresses Benefits to Russia From 'Alpha' Space Station Project

937Q0033 Moscow KOMMERSANT DAILY in Russian 17 Nov 93 p 4

[Article by Viktor Zamyatin, under the rubric "Cooperation Between Russian and the U.S. in Space": "Russia Intends To Work Out an Equitable Partnership"; first paragraph is source introduction]

[Text] **The Russian-American collaboration in space is gradually moving to a plane in which specific projects are being undertaken. During the U.S. visit that was wrapped up at the end of last week—a visit by the Russian Space Agency (RSA) delegation, which was headed by the agency's director, Yuriy Koptev—a detailed plan was coordinated for the creation of an international space station, which for now is being called Alpha. That plan was made public by the RSA head at a press conference yesterday, and it will go into effect after the signing of the agreement in December, when U.S. Vice President Al Gore visits Moscow. At the same time, the RSA and the American National Aeronautics and Space Administration (NASA) will conclude a similar agreement, as well as a basic contract worth $350-370 million.**

The new plan will replace two projects that existed independent of each other—the American Freedom project, which in fact was closed down because of financial difficulties, and the Russian Mir-2, which Russia, too, lacks the money to complete by itself. Mr. Koptev noted that the participation in the creation of the Alpha station will be 2- to 2.5-fold cheaper for Russia than would the Mir-2 project. The first stage alone of the creation of Alpha (in which the Russian Protons and the American Shuttles will deliver to the Mir station additional equipment, and in which joint flights of Russians and Americans will take place) will enable Russian enterprises of the military-industrial complex to receive contracts worth $400 million. The U.S. administration has promised to allocate that money to pay for the services of Russian firms in 1995-1997. In the second and third stages (the station is to be completed by the year 2001), the RSA head estimated that the figure may grow to $900 million. The plan, signed by the heads of the RSA and NASA in Washington, has already been sent for review to Congress and to the Russian government.

Mr. Koptev brushed aside the fears that the Americans would be the proprietors of the station. Russia is contributing to the project its own technologies and services, and, in his opinion, the overall balance will be in favor of Russia. In addition, the head of the RSA is convinced that the project itself is impossible without the equal participation of Russia in the creation of the station. It's true that for now, Russia is participating in it only as a partner. The European governments, as recently as October, were reviewing the question of the equal participation of Russia—a final decision is to be issued in early December, and it is expected to be positive. Apparently, the Europeans are supported by their colleagues, the heads of the Japanese and Canadian space agencies, which, on the basis of the intergovernmental agreements of 1988 and the bilateral agreements of those agencies with NASA, are regarded as equal participants in the project for the international space station.

Russia must also resolve a number of specific questions with the European [Space] Agency regarding, for example, the flights of European astronauts on the Mir station. As for another aspect of the participation of Russia in international space programs—commercial launches of satellites—Mr. Koptev noted that there are already a number of precontract proposals—specifically, for the launch of the European satellite Astra atop the Proton launch vehicle. The Lockheed firm will handle the marketing for that.

Russian Role Seen as Key for Success of New International Space Station

947Q0031A Moscow NEZAVISIMAYA GAZETA in Russian 18 Nov 93 p 1

[Article by Anatoliy Zak: "Keys of International Orbital Station. In the Opinion of the Director of the Russian Space Station They Will Belong to a Considerable Degree to Russia"]

[Text] The Russian Space Agency (RSA) on 16 November officially published a plan for Russia's participation in constructing an international space station. The other day, through the joint efforts of Russian and American specialists, work was completed on the process of working out the appearance of this station, which

should become a permanent outpost of mankind in space in the late 20th-early 21st centuries.

The active participation of Russia in the project for an international space station was given the green light on 15 October 1993 at a meeting of all the former participants in the Freedom program, the legacy of which will be used in large part in the new project. The first stage in station assembly, for the time being nominally called the Alpha, is planned for the period from May 1997 to mid-1998. For this purpose there will be five launches by Russian Proton, Soyuz and Zenit boosters and five flights of the American Shuttles. They will successively put into orbit and put together the base unit developed for the Mir-2 station, as well as a functional-cargo unit constructed on the basis of the transport supply ship designed by the Chelomey design bureau, two docking modules, a beam supporting the power system and an American manned laboratory. In the next stage in development of the international station (before the end of 2001) it will include Japanese and European laboratories, a Canadian robotized system, additional Russian and American manned modules, as well as an enormous beam structure supporting panels of solar cells. The permanent crew of the "settlement" will be six persons, who will live and work in compartments with a total volume of 1200 cubic meters. The station will be in an orbit with an inclination of 51.6°, which represents a compromise between Russia and the United States. The station solar cells and power plants will begin to produce a total electric power of 120 kW.

Prior to 15 December 1993 it is anticipated that solutions will have been found for all the juridical and legal problems related to implementation of this international project of unprecedented scale. The signing of the final intergovernmental documents is anticipated on 16-17 December at the time of discussions in Moscow between A. Gore, vice president of the United States, and V. Chernomyrdin, prime minister of Russia. It is assumed that during the period 1997-1999 NASA will allocate approximately 350-370 million dollars of its budget for paying for the services of Russian enterprises for implementing the project. At the same time, according to Yuriy Koptev, RSA director, for the equal- rights participation of Russia in the use of the future station a real contribution of the state to the project is needed. In response to a question concerning the size of this contribution, Yu. Koptev responded that it must be "considerable," but he declined to mention any specific figures.

The question of American financial compensation for the services of Russia remains the most ticklish at this time because in the opinion of a number of legislators in the American congress, on whom the NASA budget is dependent, American contracts with Russian enterprises will potentially result in a loss of jobs in the national aerospace sector. In addition, critics note that not one of the other foreign partners of the United States in this project will receive American financial support. However, in the United States it is clearly recognized that without the technical participation of Russia the space station program cannot be "fitted" within the narrow framework of the NASA budget and it probably will never be created. On his part Yu. Koptev states that Russia in its present-day economic situation ought not to hope for independent construction of the Mir-2 station to replace the Mir-1, which is wearing out. However, according to the RSA director, the participation of Russia in the international project will make it possible to employ 60-70 thousand people for work in the Russian space branch. The principal organizations performing this work will be the Kaliningrad NPO Energiya, the Central Scientific Research Institute for Machine Building, the Energomash enterprise and the Moscow Khrunichev Center. After a recent visit of V. Chernomyrdin, the prime minister, to NPO Energiya facilities, according to RSA information, specific decisions were made making it possible to improve the financial situation of the branch, including those enterprises which will be involved in the international program. It was decided that the salary of specialists be held at the level of 8 times the minimum pay scale. Yu. Koptev also stated that in the immediate future it will be possible to renew booster production at the Progress plant in Samara. The stoppage of production at the Progress plant has already led to the postponement of the launch of the next expedition to the Mir station from November of this year to January of next year. It is characteristic that these optimistic statements by the head of the RSA contrast sharply with his recent warnings of an actual collapse of the space branch.

In the United States an active reexamination of the national space program is underway in the light of recent agreements with Russia. In particular, the schedule of Shuttle flights for the next four years includes 10 missions for interaction with the present-day Russian orbital station. This is 10% of all the Shuttle flights. In addition, the financial support of the United States will enable Russia in December 1994 and March 1995 to launch to the Mir-1 station the two now-missing Spektr and Priroda modules which will incorporate a total of 2.5 tons of scientific instrumentation of the Western countries.

In general Russian specialists are expressing satisfaction with the latest agreement with the United States, noting that from the technical point of view "the keys of the station" will now to a considerable degree be in the hands of Russia. According to Yu. Koptev, the most probable final name of the future orbital base will be Sigma. Like the integral and summation symbol.

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